ENERGY AND WATER DEVELOPMENT APPROPRIATIONS FOR 1987

HEARINGS

BEFORE A

SUBCOMMITTEE OF THE

COMMITTEE ON APPROPRIATIONS

HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

SECOND SESSION

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ENERGY AND WATER DEVELOPMENT APPROPRIATIONS FOR 1987

MONDAY, MARCH 3, 1986.

SECRETARY OF ENERGY

WITNESSES

JOHN S. HERRINGTON, SECRETARY OF ENERGY

MARTHA O. HESSE, ASSISTANT SECRETARY FOR MANAGEMENT AND ADMINISTRATION

Mr. BEVILL. The committee will come to order.

Mr. Secretary, we are delighted to have you come before us. You may proceed as you wish.

Secretary HERRINGTON. Thank you, sir.

I would like to make a couple of brief opening remarks, if I could.

Mr. BEVILL. Yes, sir. Go right ahead.

Secretary HERRINGTON. And submit in full a statement for the record with your permission.

Mr. BEVILL. Without objection, it will be so ordered.

OPENING REMARKS

Secretary HERRINGTON. It is a pleasure to present to you the Department's Fiscal Year 1987 budget. It has not been an easy task putting this budget together, as you might well guess. However, I am confident that with the choices we have had to make it is a sound budget that fits appropriately within the President's overall priorities.

As you are aware, late last year Congress passed that historic Gramm-Rudman-Hollings Balanced Budget and Emergency Deficit Control Act. This act mandates a difference of sharply lower deficit ceilings until 1991.

This is a worthy goal to me and I think it is to all of you and we need to accomplish this goal. To do so the Congress and the Administration need to work together.

The President's budget for fiscal year 1987 keeps his end of the bargain. If accepted, it will bring the budget deficit down to the target of $144 billion.

The Department of Energy's portion of that budget is $12.1 billion. That is about one percent above the Fiscal Year 1986 levels of funding as adjusted for the President's sequester order issued on February 1st. There is no question that our budget is lean, it is sharply focused, but I believe it to be a fair budget.

It provides sufficient funds for our defense functions to meet the requirements levied on us by the Department of Defense and it provides adequate funds for all essential activities of our general science and energy missions.

It is a budget which is fully responsive to our energy policy and energy goals. This budget applies Federal funds where they are most needed. For example, to remove technological barriers, to increase use of this Nation's vast energy supplies, to continue measured development of possible energy technologies in the future, to pursue the safe disposal of nuclear waste which is something very important to us, to continue our research into the fundamental constituents of matter and energy and the basic forces of nature, and to improve the safety, security and environmental protection and clean-up at the Department's facilities.

This is a new program this year. As you know, we have reestablished the position of Assistant Secretary for Environment, Safety and Health. We have funded that program at $47 million, and we have set priorities for identifying our most troublesome and difficult spots within the Department.

There are some special initiatives in this budget which I want to mention. Some are not really new and some are not surprising. But there are a couple that need to be mentioned.

The budget proposes privatization of the Naval Petroleum Reserves and defederalization of the Power Marketing Administrations. There is no national security reason for the Government to continue to retain the Naval Petroleum Reserves in my estimation.

The Strategic Petroleum Reserve today can pump oil out 30 times faster than the Naval Petroleum Reserve. Defense petroleum needs, as we see them today, are met primarily on the open market.

The sale obviates the need for Federal funds for increasingly expensive secondary oil recovery we are now engaging in.

Turning to the Power Marketing Administrations, the Power Marketing Administrations, as they are constituted today, do not uniquely serve Federal purposes. They can be run equally or more efficiently by non-federal organizations or regional entities and they can be subject to regional control.

At the same time as we are proposing the Power Marketing Administrations for sale, we will also be proposing legislation to reform their Federal investment repayment practices. It is not the same proposal as last year which called for repayment at current market rates. It is a proposal to repay at the existing interest rate that is in effect on the outstandng unpaid appropriated investment.

The budget proposes a moratorium on further development of the Strategic Petroleum Reserves and a cessation of fill to a later year when 500 million barrels of crude oil will be in storage. The SPR represents a wholly adequate supply of oil and an insurance policy as Congress set it up given the oil market situation today and the foreseeable future.

The oil moratorium will be reassessed as economic and world market conditions change and should be monitored both by the Department of Energy and by Congress.

Finally, this budget strongly supports important initiatives announced last year to ensure safety, security and environmental pro-

tection. There is enhanced attention to these issues and it is one of my highest priorities.

It is a management requirement today for all organizational departments of the Department of Energy. We are going to try to—taking up the next subject, I didn't want to tie the two—taking up the next subject we will try to leverage scarce Federal funds for research and development by taking minority positions with industry in cooperative research and development consortia. Cooperative Federal research and development ventures with industry will not only increase the impact of Federal funds, but will more importantly improve technology transfer, something that I think we need to do.

In Fiscal Year 1987, our fossil energy program is going to undertake a cooperative research and development pilot program. That is funded at $12 million, I believe, this year while conservation and solar programs will investigate the possibility of similar programs with industry.

A significant feature of this budget compared to 1986, is the withdrawal of further Federal support for conservation grant programs. The States are recipients of extremely large sums received in restitution for oil pricing and allocation violations. These sums are available for conservation activities and additional Federal support in our estimation is unnecessary.

This budget builds on the foundation of energy stability and security which we have laid during the last five years. It will move us another step closer to our goal of energy strength and in tandem with the budget initiatives outlined by the President and Congress, it moves this nation closer to a balanced budget while allowing us to continue the essential activities of the Department of Energy.

That concludes my statement. Thank you very much.

[The statement of Secretary Herrington appears at the end of this hearing.]

ENERGY PRIORITIES

Mr. BEVILL. Mr. Secretary, the Fiscal Year 1987 budget request for the Department clearly reflects the Administration's budget priorities in the current fiscal environment. There are large increases in defense programs and large decreases in most other programs. Do these priorities make sense from a long-term energy security perspective as well as from a budgetary perspective?

Secretary HERRINGTON. I would say a couple things on that, Mr. Chairman, if I could. The increase in defense activities under this budget reflects the agreement between the President and the Congress of a three percent real growth in defense spending and we have targetted directly at that.

They are also driven by two other factors in that growth. Number one, the requirements placed upon the Department of Energy by the Administration's priorities in the defense area, namely, the Strategic Defense Initiative, and also our obligation to meet requirements under the Nuclear Weapons Stockpile memorandum, which we are required to do.

Those are our principle focus on defense. Taking those with that three percent growth and with the Gramm-Rudman requirements,

I think we have reached an acceptable medium in balancing between the energy programs other than defense.

MANAGEMENT OF THE DEPARTMENT

Mr. BEVILL. During your appearance here last year, Mr. Secretary, you indicated it was a priority of yours to manage the Department of Energy as the best-run cabinet part of Government. Do you think you have accomplished this and what steps have you taken to do so?

Secretary HERRINGTON. Well, there are several things that have happened in the last year. I believe that we have a very tight management chain. I think we have some outstanding people working in the Department as constituted today and we have gone to great lengths to evaluate ongoing programs and manage them well.

It is my belief that we are doing business very well today. Not to say that it was not being done well in the past years, but the Department today, I think, is extremely responsive to the taxpayers, to fiscal responsibility and to Congress and we intend to keep it that way for the remainder of this Administration.

Mr. BEVILL. Very good. I recognize Mr. Myers.

Mr. MYERS. Thank you, Mr. Chairman. At this time I am going to yield to Mrs. Smith, our colleague, who will not be able to stay the entire time.

POWER MARKETING ADMINISTRATIONS—PRIVATIZATION

Mrs. SMITH. I thank the gentleman for yielding. I really have only two questions. The first one deals with the privatization of the Power Marketing Administrations particularly WAPA, which serves my area.

Did I understand you to say that we would not be increasing the rates to the consumers if this were privatized and how would this be managed?

You know, last year when this proposal was made we did a lot of figuring in our area and it would have doubled or in some cases a little more than doubled the cost of electricity.

Secretary HERRINGTON. Yes, ma'am. I may have given the impression on the interest rates as I was speaking—my statement was that we feel that under the current repayment proposal our analysis tells us that between a seven and thirteen-one-half percent wholesale electric rate increase could be expected for some of the Power Marketing Administrations. As it relates to WAPA, we anticipate no increases in utility rates under the repayment proposal of that program.

The one thing I said in my statement that might have been confusing is that this year on the repayment proposal we are advocating existing interest rates that are now in full force and effect versus last year when we were projecting market rates which, in many cases have been seven, eight, nine percent T-bill rates.

So I think you are correct to summarize no increase in utility rates from the repayment proposal for WAPA. There would be increases for others and the payback would be the same as it is now with a better schedule.

MIDWEST ECONOMIC CONDITIONS

Mrs. SMITH. You know, this is very, very important out across the midwest where our financial condition is much worse than it was last year. Last year our university figured that it cost $1.12 to pump the water to raise one bushel of corn. If we increase that rate, we are selling that corn right now for $2.26 and you go broke raising it, and we pump water for 80 percent of all our row crops.

NATURAL GAS PRICES

This is very, very important. Then I wanted to ask about your proposal that we raise the price for old gas from 74 cents to 256 a BTU. You know, 70 percent of our homes in Nebraska are heated with natural gas. We are dependent largely on oil, old gas reserves.

What would this do to our prices?

Secretary HERRINGTON. Our proposal to FERC to eliminate vintaging of old gas we believe would have the effect of allowing gas to rise to maximum of $2.52. We believe that for the benefit of the country, including people in the midwest, the full deregulation of natural gas, including repeal of the Fuel Use Act, and including provisions for free and open access to transportation systems, is the right thing for the country to do to make energy available on a wide, broad base of the population and to help production of our industries. We think in the long run that the deregulation will provide probably an extra three trillion cubic feet available to the American people and in the long run will become cheaper for them as an energy source.

We also believe that a lot of the old gas that you have referred to in the 74 cent range is not getting to market and is not being used. It is locked in the ground. That is the reason for our deregulation proposal.

EFFECT OF DEFEDERALIZATION ON FLOOD CONTROL

Mrs. SMITH. Just one more quick question. How will the privatization of these power marketing agencies affect the basinwide flood control programs and power exchanges?

Secretary HERRINGTON. I think it is too soon to tell all the implications. These are, as you can surmise, extremely difficult and complicated financial transactions that we are proposing. Probably some of the most complicated anywhere in the economy today.

They need to be looked at, studied, evaluated for a substantial period of time. That has not been done.

We would like this proposal to minimize the impact as much as possible on the areas that you have identified.

Mrs. SMITH. Thank you. I thank the gentleman for yielding.

Mr. BEVILL. Chair recognizes Mrs. Boggs.

Mrs. BOGGS. Thank you.

Mr. Secretary, Madam Secretary, it is very nice to have you here and to have you accompanied by such splendid members of the Department of Energy.

STRATEGIC PETROLEUM RESERVE

Mr. Secretary, your budget proposed to defer for a second time funds appropriated in the Fiscal Year 1985 budget for construction of various facilities of the Strategic Petroleum Reserve located in Louisiana and Texas. Last Tuesday in response to congressional inquiries the General Accounting Office determined that $156.8 million of the funds proposed for redeferral constitute an impoundment and in accordance with the 1974 Budget Act, the Comptroller General has advised you that the funds involved must be made available for obligation. What is your response to this finding regarding the funds in question?

How do you intend to proceed with the release of funds appropriated for construction of the SPR?

Secretary HERRINGTON. Yes, Ma'am. The decision by GAO on the deferrals has broad government-wide implications, needless to say, not only for this Administration but also for Congress. It involves obviously a review on an intergovernmental basis, involving the General Counsels of a number of departments, and has implications far beyond simply our energy budget.

I have instructed our attorneys to begin that process as rapidly as possible so we can bring this issue to a quick resolution. I don't have an answer for you today on what our position will be.

Essentially, the Administration proposed deferrals. The GAO opinion came back and said we were not doing it properly. I honestly am not in a position to say what the legal basis is on either side. I do know we need to work it out and it has to be done as soon as possible.

Mrs. BOGGS. As you have noted, GAO determined on February 25 a proposed redeferral amount to be an impoundment of funds because the Administration's justification for the redeferral was identical to its justifications for the original deferral which was explicitly rejected by the Congress.

Secretary HERRINGTON. That is the issue of no changed circumstance. It is a legal issue and I honestly don't know how to respond to you on where we are on that point. I understand the question. I don't have the answer.

Mrs. BOGGS. What are the Department's plans for the funds not covered by the GAO ruling?

Secretary HERRINGTON. We have no plans. We will continue to spend those funds that were not covered by the GAO opinion. I don't see any change.

Mrs. BOGGS. Well, I really don't understand the Administration's logic in this matter. Everyone agrees we need a substantial reserve and world oil prices are at their lowest in a decade and because of the market prices in our own oil producing area, the construction funds needed to finish this SPR can be had at the most reasonable price you will probably ever be able to get.

Also, President Reagan has made assisting Mexico in its financial crisis a priority and yet the Administration proposes to suspend the purchase of Mexican oil, a step that will have a serious impact on the Mexican economy. It really does not appear to me the Administration's policy in this regard makes very good sense.

Secretary HERRINGTON. The logic of the position I would be happy to give to you.

It depends on how you view it. The logic is this. When Congress set up the Strategic Petroleum Reserve and mandated a certain level of protection for this country, the issue was debated at that time on how much we would need to protect the United States from foreign dependence and it was generally agreed by experts that 90 days was sufficient protection for this country.

Today as we sit here we have over 120 days protection in the ground of imports based on today's imports and probably three years of protection from OPEC imports. That is a pretty good insurance policy.

The question that we are facing today is, do we go ahead and buy more insurance filling up to the 750 million barrel level at a time that our national deficits are running in the $200 billion range and our national debt is approximately $2.43 trillion?

The logic is this. Now is the time we can afford maybe to work on the budget a little more than on the filling of SPR and that is the Administration's position.

Mrs. BOGGS. Well, the real problem, Mr. Secretary, is that the larger volume is what was considered to be in the national interest and if the old song has value, if one forgets the lessons of history, he is fated to repeat its mistakes.

We can't relax because our oil prices are low, because the flow is coming into the country. We have to recognize that all of these relaxed atmospheres were in place when we got into the terrible difficulties we encountered that made the SPR a necessity.

When you think back on the economic dislocation not only in this country but all over the world and we recognize that following our problems we were able to institute the finest kind of conservation measures, we became more energy independent because of them and if indeed we began to be relaxed about a sufficient supply at reasonable prices and an uninterrupted flow so that our national defense and that of our allies is not threatened, I think we relax into that sort of situation instead of being determined about continuing the fill of the Strategic Petroleum Reserve and continuing the building of the areas in which the fill can be held that we really are disregarding the lessons of history.

Secretary HERRINGTON. The only answer that I would like to add to what I said before is that there is a great deal of flexibility built into the SPR system. I think that with this kind of protection in the ground if circumstances should change, we can, in better budgetary times when we are better able to perhaps afford this type of an investment, expand that and go forward with the modifications and the continued filling.

It is our position that we think we have enough to maybe stop and take a look at it a little bit.

Mrs. BOGGS. When you think about the cost of stopping the construction and especially a time when the construction can be had for much more reasonable rate than it can in times of good financial conditions and you think about the monies that you could spend now when oil is at such a low price and you balance that against what we have to spend for construction and for fill at a later date when the prices are higher, I don't think the Govern-

ment is going to save any money and it will be, of course, ignoring the national security.

Secretary HERRINGTON. I understand your position. I am also confident that in taking this moratorium position that the Administration is acting responsibly and trying to give the country as much protection as it can under these budgetary conditions that we are now living under.

DEFERRALS

Mrs. BOGGS. Mr. Secretary, I would like to discuss another deferral. You have now converted the proposed deferral of university labs up to a further rescission. I think it is unlikely Congress will go along with this particular rescission.

If I am correct, how do you propose to move forward with this process?

Secretary HERRINGTON. We will move forward immediately and carry out the instructions that were given to us last year by Congress.

Mrs. BOGGS. Mr. Chairman, I have other questions that I will submit for the record, if I may, because I realize I have overstepped my time.

Mr. BEVILL. They will be submitted for the record, and you may answer them in the record. The Chair recognizes Mr. Myers.

Mr. MYERS. Thank you, Mr. Chairman.

Welcome back to the committee, Mr. Secretary, Madam Secretary, and all your supporting staff here. We have a supporting staff here, too, to tell us what to do all the time. We don't always do it, but most of the time.

NATIONAL ENERGY POLICY

Mr. Secretary, I share somewhat the thoughts that the gentlelady from Louisiana has expressed here, maybe not necessarily exactly along the same line as far as filling SPR at this time, however, it would be a cheap time to fill it as the price continues to go down from, slightly over $13, the current spot price and some are predicting in this morning's paper, that it will go as low as ten. This would be a cheap time to fill SPR, but I am concerned about national policy at this time when we are now finding oil to be cheaper in comparison maybe to other sources of energy that we might turn back towards using more petroleum production now and away from nuclear that we have turned away from anyway, and less use of coal because of the cheap price of petroleum today.

I am concerned about this. It could happen, I am afraid. You and I have discussed this on occasion but I am interested in what role you play in cabinet meetings. Is future energy need predominant or is that balancing a budget commands the most attention?

In this regard, I am concerned that the President seemed to be softening on the oil import tax which, of course, it would be easy now to stick a tax on oil imports because oil is getting so cheap, the consumer wouldn't realize it, but I don't know how long this is going to last.

I wonder if energy policy is made in cabinet or is it made outside of cabinet meetings? At what level is policy made today?

Secretary HERRINGTON. Well, the President makes policy.

Mr. MYERS. On his own then.

Secretary HERRINGTON. Not on his own. Obviously with the Executive Branch in cooperation. We have an economic policy council and a domestic policy council, both of which are subdivisions of the cabinet, and I am a member and active participant in both. Those issues are worked up through the policy chain, and taken to the President for a decision.

I think the process is excellent. It is the first sub-cabinet organization of its type that has been in use. It has been very smooth.

We have discussed the points you make about getting back to more dependence on petroleum products. I think there will be a small increase in the use of petroleum products, sure. But there is one thing you can't take away from this country and that is the progress we have made on conservation and efficiency.

There was an outstanding article in the Wall Street Journal a week-and-a-half ago, a very thoughtful article on how our factories are turning out new types of appliances, more efficient engines, more efficient electrical motors, and insulation. There are improved standards in building codes, and builders that are building more efficient homes. The public is aware of energy conservation today. It is a common word in our vocabulary.

It goes on and on through other examples. We have turned a corner in our energy future. Now, that is not to say we can't do better.

But we are never going back to where we were. We might slide a little. Even the biggest car you can buy today out of Detroit still gets 20, 21 miles to the gallon. The point is that when we have problems such as prices going down or prices going up that we do not as a Government step in and try to save everybody and solve the problem because we have found through experience that the Government does not do as good a job as the free market and the private sector.

If you are interested in energy future, and this committee certainly is, then there are things we can do. We can deregulate natural gas. We can do it right away.

That will make more low cost gas in large quantities available to this country on a cheaper basis. We can pass a modification of the nuclear licensing law we have been looking at for a long time.

We have over-regulated ourselves into oblivion in nuclear energy while the rest of the world has been doing a good job like the French, Japanese, West Germans and other countries. There are a lot of things that we can do to help the situation we are in.

We don't necessarily have to try to support an oil market or support a gas market. We can let this economy work. That is essentially my answer.

Probably two more things I think are important as long as we are on a long list. One is to continue our work of learning how to burn coal cleanly. We are sitting on a 400 year supply of coal in this country.

We have done great things since 1973. We have a ways to go.

Finally, we must keep up our conservation and efficiency efforts that are going on. Thank you.

Mr. MYERS. I remember 40-some odd years ago we learned in school that we had a 400-year supply. That was 40 years ago and we have still got it. Haven't burned much, have we?

Secretary HERRINGTON. We are burning it more and burning it better.

NUCLEAR PLANT LICENSING

Mr. MYERS. You mentioned nuclear plant licensing, which has long been an issue this committee has been concerned about. Again, the delicate balance you play in this procedure is one of not directly managing nuclear licensing but do you see any hope in the future?

Secretary HERRINGTON. I certainly do. The bill that we have sent to the Hill under consideration by the Congress now is not the best bill that we could ask for, but it is a good bill. It takes a bite out of the problem. We have to start down the line somewhere.

There are too many problems to sit with the status quo. I don't think we as responsible administrators in the Government and as elected officials can allow this country to go into the year 2000 without a simplified nuclear licensing process. It is not good for the country and we have seen that other people are doing the job well and they know how to do it and we can follow their example for once.

NAVAL PETROLEUM RESERVE

Mr. MYERS. Back to the Naval Petroleum Reserve, which was established years ago as a security measure for this country. In the middle seventies when we had oil petroleum problems, we started expediting and using them as rapidly as we could and the Administration is proposing that we sell that. I am not sure I agree. Possibly we should not be pumping it.

I think probably we don't need to do that right now, but even though we have 120 days reserve and we are relying more on oil, at least in the Western Hemisphere, how long that is going to last, I don't know.

But have you proposed legislation to authorize the sale of the Naval Petroleum Reserve?

Secretary HERRINGTON. We would do it through the legislative process. We would like to look at it and study it but basically the SPR pumps out oil much better than Naval Petroleum Reserve. The Government takes in about $1.3 billion today from the Naval Petroleum Reserve, but it is declining. By 1995 you will be down at $0.6 billion instead of $1.3 and that is decreasing because the field is running out.

What we would be selling today would be an income stream from reserves. American industry, especially the oil industry, would be interested in buying reserves, and we could get a very fair price.

The question I have is what is the U.S. Government doing running the seventh biggest oil field in the country? I don't think we do it as efficiently as the private sector would do it and I think we could use the money somewhere else. It is not the kind of business we were set up in. We have passed that justification of the 1930s to

back up the United States Navy, which now is running on gas turbines and nuclear power, and has better sources of supply.

DEFENSE ACTIVITIES

Mr. MYERS. About two-thirds of your budget request is for weapons or weapons materials. It seems like that is growing more rapidly than any other part of your budget. Do you think it should remain with the Department of Energy or should we transfer that at some future date over to the defense or should we create a new cabinet officer just to handle nuclear weapons?

Secretary HERRINGTON. I don't think that is necessary. Two points we could make. Number one, the scientific community is doing an excellent job. They are non-military.

I think they would prefer civilian leadership versus military leadership. Historically, that has been a good thing in this country since the AEC was set up back in the forties, and how we are doing business in that area I think is excellent. Yes, it is a fast growing area of our Government, but it is growing for one reason and that is the Strategic Defense Initiative which is a high priority, and I think one of the finest programs that has ever been put forward for arms control.

Yes, there is money being spent on it, but we are going to get a return on spin-off benefits for the private sector, on technology that we develop and learn during this process. The figure 67 percent that you use on defense activities or two-thirds, I think I have to say one thing about that.

I hear a lot of figures about how much we are doing on defense activities. If you take that percentage of our appropriated funds and you exclude those defense activities that are essentially non-weapons activities such as environmental, health and safety, security protections, and upgrades of plants that have gone in disrepair, you won't get a 67 percent figure.

The thing people forget is the Department of Energy enriches all the uranium, and runs all the Power Marketing Administrations. We have a "GNP" in the Department of about $19 billion. If you put that up against defense, our defense activities are in the 43 percent area, and I think that is a legitimate way to look at it.

CIVILIAN USE OF NUCLEAR FUELS

Mr. MYERS. You mentioned the spin-off that we do realize in the civilian use of nuclear fuels. Is that continuing? Do we continue in the research for weapons? Do we still have a spin-off in the civilian side?

Secretary HERRINGTON. One of the things we are really attempting to do is to do our job better in technology transfer. We are interested in getting some of this pure research into the private sector.

We are looking at patent policy, we are looking at foundations such as the Rio Grande Foundation in Mexico, some others where we can start imparting some of this research off to the private sector.

Yes, I think that is a large benefit that we get out of this type of research.

INTERNATIONAL COOPERATION ON FUSION

Mr. MYERS. I have some questions I will provide for the record, but I have one more question. We had a working relationship a few years ago with the Soviets on fusion. This committee is still deeply concerned about the tremendous amount of money and research that we have been appropriating through the years, but we still seem to be not just quite reaching a working reactor for fusion.

The Soviets possibly are even getting ahead of us now. Is there any discussion with the Soviets to re-open that exchange so we can exchange technology that you are aware of?

We are going to get into this a little bit later on, I know, with Dr. Trivelpiece and others on this particular issue, but these meetings with Gorbachev, did we ever get into these areas or is there some exchange today?

Secretary HERRINGTON. This particular area was discussed at Geneva and it was a part of the communique on multinational cooperation and collaboration on fusion. There is still interest in this country and by the Department and by the President to work towards some type of arrangement.

We need to work out details. I am sure it will be discussed at the next meeting. The Tokamak reactor up in Princeton is a full exchange type project. We have a number of foreign scientists and ours who work side by side. There is a great deal of exchange going on which has a great deal of promise.

As you can see from the budget, that is the one we have continued at level funding, while making the hard choice on the Mirror Fusion Project not to continue it any further. I think that there is a good future in this type of activity and I think you are seeing some of it with money you have spent, you have seen some return for it.

Mr. MYERS. Most of the members of this subcommittee have been appropriating money for fusion research ever since they came on this committee. That is all they have ever heard is fusion research. Yet we still seem to be getting further down the road before we can get a working, on-line Tokamak.

Secretary HERRINGTON. One of the problems obviously is they are ready to go to the next step and it takes big dollars. There is a working group working with the Soviets. Dr. Trivelpiece is deeply involved in this.

Probably the next meeting will be in June, but I think there is reason for optimism in this particular area. The Tokamak is an extremely successful project and I have visited it several times and you probably have, too. It is an outstanding project.

Mr. MYERS. We were there when they were putting the foundation in. It has been a long time ago. It is beginning to look like we are going to have to have more cooperation with other countries. Tokamak seems to be a one-way exchange. We exchange with them and what do we get back for it?

We will be talking to Dr. Trivelpiece, too, later on but I hope we will encourage greater participation with other countries, Japan and the Soviets, I guess, are the two principals and we will talk about that later I know but we have simply got to have a greater participation with these other countries in exchange. And, of

course, the French are way out there, too, the fast breeder which I guess we just about accept in name only.

FAST BREEDER REACTOR

We still are concerned about the fast breeder reactor. I know you have nothing in your text here on that, but it is still a system I think at some time maybe we will blend in to make a balanced system in the fission, but nevertheless, I hope we will encourage greater participation with other countries because I think it is absolutely necessary.

I think most of you do, too, but we should be concerned about future needs of energy and again I hope there is no de-emphasis on the part of this Administration, I know it isn't on your part, but I was not critical a moment ago about any particular reason why I was asking how decisions were made.

I may have left the impression I was critical of some decisions, but I am not blaming anybody for that. I am trying to find out who made the decision. I just think we ought to continue to be concerned about future energy needs for our country because right now it is going down cheaper except electric power. I still get letters on that.

But that, too, I think will level off maybe in the future when we start using more nuclear. We will get down to where it will be cheaper.

I just hope we will continue the concern about the future needs for our children and grandchildren. Thank you very much for your testimony.

I have some questions for the record that I will put in.

Mr. BEVILL. Chair recognizes Mr. Fazio.

Mr. FAZIO. Thank you, Mr. Chairman.

Let me apologize to my colleagues. I have a number of areas of inquiry here that I do want to try to deal with on the record. I will put some questions in but I think we have not sufficiently touched in depth on a number of issues that I think I must bring out here.

I would like to welcome you, Mr. Secretary, and your staff, but I must say that I have a number of problems with this year's budget, not just the radical shift over the last five years in priorities that was touched on by Mr. Myers, but with a number of policy decisions that are either made or not made and I think that is sometimes even worse in this budget.

INTERTIE DEVELOPMENT

I would like to begin, though, by thanking you for the cooperation that you extended this committee and the public and private utilities in California in the development of the international intertie of the northwest which, of course, does help you, and help the Federal Government by allowing Bonneville to have the kind of income it needs to pay off the loans that it was in receipt of for the development of that northwest power agency.

But it seems that in furthering that intertie, we acknowledged that there is a public purpose, in this case a Federal Government purpose, in having control of the system that allows us to shift power across this Nation from one grid to another to maximize the

available power in areas where there isn't surplus, to in effect make our total energy supply system more efficient and yet in this budget when you want to call it privatization or defederalization, what I call a fire sale mentality, the Administration for reasons that I think are entirely ideological and political, wants to sell off our power marketing administrations.

POWER MARKETING ADMINISTRATIONS

I think the public interest issues here go far beyond what rate increases might occur in my region or somebody else's. I think we are going to lose that capacity to plan and implement inter-regional power agreements.

I think we are going to do nothing to reduce the drain on the money markets. If a private utility goes out to borrow money to purchase at higher interest rates, current interest rates, a public agency, I fail to see what benefit the one-time, short-term sale of assets deficit reduction scheme produces.

They are both going in to borrow money, whether it be a private entity or public entity paying off an old debt. We get no help, therefore, really in terms of our deficit reduction goal leaving more capital for private investment. We simply on the basis of some assertion that we don't manage things as well publicly as we do privately, and I might point out by the way for the record that SPR and our petroleum reserves are contracted out to the private sector, we simply are fulfilling an ideological commitment to get rid of these assets which are in the long run going to bring us more revenue than we are going to gain in a short term sale.

I quote the gentleman who resigned, Mr. Pelz, when he says from a financial point of view I think a sale would be unwise and counterproductive because over the years it would cost the Government more money than it would take in.

I think he was right. I don't think his point of view has been adequately considered by the Administration and that is why I think he has quit. I simply want to further the comments of Mrs. Smith and some others on this committee when I say I think you are wrong and you are making a big mistake.

I wonder if you have any response on the sale of the power marketing administrations?

DEFEDERALIZATION PROPOSAL

Secretary HERRINGTON. Yes. I think a couple of things are legitimate. Number one, nobody is contemplating nor would I think stand by for a fire sale. The idea is to begin to look at defederalization.

It is going to take some time for us to review all of the pros and cons of this proposal. It is not something you can just say let's do it. You need to look at financing methods, who is going to buy it, and the type of apparatus that would assume operations.

Number two—

Mr. FAZIO. But you already have a big savings in this year's budget from the sale of these assets, isn't that correct?

Secretary HERRINGTON. That is correct.

Mr. FAZIO. Isn't that a bit premature if we are just starting to look at the pros and cons?

Secretary HERRINGTON. 1988 is when it starts.

The proposal is to start in this fiscal year.

Mr. FAZIO. The reason I mentioned fire sale is because I understand they are valued at $12.7 billion which would be in effect to pay off the unpaid investment on those existing systems. The Grace Commission says they could be at least $77 billion in value and I have seen other estimates—the Heritage Foundation says $100 million.

Secretary HERRINGTON. I think those are legitimate numbers. The question I ask you is, is the Federal Government in the business of making a profit off of Federal activities that are serving a public policy purpose? I think the answer is no.

We are not in the business of going out and maximizing a sale price and further complicating the situation. The problem is that there is approximately $12 billion of U.S. Treasury money invested that we have to borrow from the capital markets and is not being paid back from the Power Marketing Administrations on a reasonable payment schedule.

Mr. FAZIO. We have increased the wholesale power rates markedly in the last several years. SMUD in my district had a 28 percent increase last year in order to increase our repayment schedule to try to fulfill our obligations and meet the criticisms of people in the Administration.

That is quite a different matter than simply putting on the market, for what I think are artificially low values, a system that has the potential to continue to fulfill commitments to regions of the country that have been developed on the premise of reasonable power rates and at the same time overlooking the tremendous windfalls to the Treasury that will help with deficit reduction when these facilities are amortized, when they are paid off.

Those revenues will go totally into Treasury into general fund purpose.

Secretary HERRINGTON. We don't make any money on the Power Marketing Administrations. It is a break-even situation for the Government. The problem is that people in the eastern part of the country and southern part of the country, for instance, are subsidizing activities in another sector of the economy.

Mr. FAZIO. What evidence do we have? Are we losing money on the Power Marketing Administrations?

Secretary HERRINGTON. We have to go into the market and borrow at current interest rates the money that we have invested that is not being paid back. Now, that costs tax dollars.

Mr. FAZIO. We are making payments and you would argue we should be making them at current market interest rates instead of those rates that were established when the projects were started. That would be like telling somebody with an eight percent mortgage that they have to pay 13 percent because that is what everybody else is paying today.

Secretary HERRINGTON. The proposal this year is to pay at existing rates. There is no proposal in front of you to increase the interest rates whatsoever.

Mr. FAZIO. What interest rates are you asking people to pay at?

Secretary HERRINGTON. About 3.5 to 4 percent is what the weighted average interest rates are on the unpaid Federal investment. That is the payback.

I think that is a reasonable payback.

Mr. FAZIO. You are just committed to going forward, though, on what premise? Let me ask you to restate it.

Secretary HERRINGTON. Well, I think you have to look very carefully at what basis you want to defederalize these and I think that takes some studying. As I said before, it is a complicated financial transaction.

The point is that these administrations can be run better from a regional basis or a local basis than they can from Washington, D.C. Who knows the problems better in the Bonneville area than the people that live in the Bonneville area?

Mr. FAZIO. Isn't that where these administrations are located? I have WAPA in my district. They are regionalized. We have a regional office in Sacramento.

I don't think Washington, D.C. is running the power administrations.

Secretary HERRINGTON. I have to disagree.

Mr. FAZIO. They come visit us when they need some money once a year, but—

Secretary HERRINGTON. They are part of the Department of Energy. They are governed by overall Federal policy. The situation we are in today is that the Federal Government is attempting to recoup the investment on a payback schedule and the regional entities are not agreeing on the payback schedule. So there is a difference in interest between the two, no question about it.

Mr. FAZIO. They are much closer to the people who are impacted by the rate increases. That is the difference.

Secretary HERRINGTON. I think they are, and that is why they ought to be able to operate the regional power administrations.

SALE OF POWER MARKETING ADMINISTRATIONS

Mr. FAZIO. Who is likely to buy them? Isn't it the private utilities in the area that would buy them up? As I indicated before, they would go into the money markets at higher interest rates taking up that capital that we might invest in something else simply to change the lock on the door?

Secretary HERRINGTON. I think that is one possibility. Other than the local utilities, you may find a structure of interstate agencies or regional compact that would run BPA or WAPA. I just don't know who the buyer would be. There certainly would be buyers.

Mr. FAZIO. In the case of Mr. Weaver's suggestion, if we were to go out and use municipal bonds that would cost the Government even more because those are tax-free benefited and Treasury's loss would be even greater.

Secretary HERRINGTON. Entirely different issue.

That is a taxation issue on deductibility of interest of municipal bonds. If the tax law stays the same, you could well be right depending on how much was borrowed and taken out of the private sector.

I don't think you should confuse that issue with whether there is a Federal purpose in operating the power marketing agencies.

Mr. FAZIO. I agree, the basic issue is whether there is a Federal purpose or not and I think the people who benefited from having power available through the Federal power administrations through the years certainly think there is.

I guess we will have to study it a good deal more but I think it is premature to factor any savings into the budget process. I think you are a long way from home on this one.

HIGH ENERGY PHYSICS

I would like to go on to another issue that is very high profile in certain regions of the country and that is the whole question of where we go with high energy physics.

This committee in the last several years has augmented the Department of Energy's budget to consider the possibility of building something that most people on the cutting edge of high energy physics think is really the next step, the superconducting super collider, the concept of a new effort.

I know the President alluded to it in his State of the Union speech. I think I heard you say a few words that implied we were going on to look at another level of matter beyond leptons and quarks to even smaller particles to know even more about what constitutes this planet and the people and other organisms that inhabit it.

The opposite, perhaps, of going to the farthest ends of the solar system. I wonder, where in this year's budget there is any kind of assertion of policy by the Department of Energy as to what our future would be and where we are going in this whole range of activities in the area of inquiry.

I see this as a very crucial year. I know a number of States, including my own, are working to propose ways in which they can cost share with the Department. Certainly it is an area where we might even want to look overseas, but I see a halt, a failure to pursue the issue and I wonder, is this budget deficit driven? Are we going to give up our leadership in this area of inquiry because of our budget deficit or perhaps is there a policy decision on the part of you or others at the cabinet level?

SUPERCONDUCTING SUPER COLLIDER

Secretary HERRINGTON. The SSC, or the Superconducting Super Collider, is an outstanding project and it is one that needs to go forward. It is a $6 billion project.

That is the problem. I don't think it is necessary at this point in our evaluation to have any more money in the budget to decide the pros and cons of it. We are at a point where we have to decide to go or not go; putting another $20, $30, $40 million in it to look at it some more is a waste of money.

I am sorry. It is not a waste of money. It is probably not a priority use of money. We, as a country, and as a Congress, need to decide if that is a national investment that we want to make.

I do not want anything I say here to discourage our enthusiasm for that project. I think it is an outstanding project. A number of

States, California included, Texas, Colorado, Illinois, have all put money up in looking at getting that project and how it would be developed. That is admirable.

We have a report coming in this summer, further evaluations. We do have some unspecified money. If further research and development is needed on that project, we are able to provide it, but I think we are past that now, Mr. Fazio.

We are ready to decide to build it or not build it. I would like to see it built myself. I don't know if we can afford it with Gramm-Rudman and the budgetary constraints we are in.

I think that is a decision the Congress has to look at.

Mr. FAZIO. I am a very strong enthusiast for moving forward in high energy physics. I realize there are potential drains on other research budgets that might occur as a result of this decision, but I think it is something we should continue to pursue.

I am trying to recollect—this Administration said a few years ago it would take about $140 million to make the decision as to whether it was feasible to move forward. We have had to augment your budget several times now to get to about 40 perhaps or slightly higher. All of a sudden it has been concluded we don't need to know anymore.

This was obviously a highly inflated proposal then when we started because we are not even half way, as I understand it, to the numbers we felt we had to reach to be in a position to know just what the project was all about, and what it would take to put it together.

All of these people, both in the States and other countries that might be at some point part of our effort, are kind of left hanging without any direction. When will we have an answer?

Secretary HERRINGTON. Well, I think I have given you the answer. The answer is we are ready to build it or not build it. I think Dr. Trivelpiece can give you the technicalities on what research has been done and what position we are in.

Mr. FAZIO. When will we make a decision to build it or not build it?

Secretary HERRINGTON. I think that is up to the Congress.

Mr. FAZIO. Are you making a proposal to the Science and Technology Committee to build it?

Secretary HERRINGTON. As I said here today, I am not prepared to make that proposal in 1987, because we cannot make that proposal and still meet our Gramm-Rudman targets of $144 billion. It just isn't there.

BUDGET PRIORITIES

Mr. FAZIO. Well, the Department's budget, as we have discussed, is now only 29 percent non-nuclear systems development. Of course, we have had a one percent increase in that portion for general science and certainly a declining amount for non-nuclear development systems doesn't leave much room for any new initiatives. I understand that.

I guess it is a question of whether OMB believes this is important and whether they believe any activities at the Department of

Energy are important because that is really where you stop, isn't it, is OMB?

Secretary HERRINGTON. I don't think so. This budget is worked out between us and OMB and we fully adopt this budget. I don't want to lay off the responsibility of this budget to OMB. We agree this is a tight, lean budget and it does a lot of good things.

As far as new initiatives, I think you are seeing a bunch of them in this budget. One of the biggest is the effort of the Federal Government to joint fund programs with the private sector. That is a really good initiative in this budget.

Mr. FAZIO. We have had a number of those initiatives in the past and this committee has been very cooperative in supporting them. I would like to just touch on two of them where our efforts to work with the private sector seemed to have come a cropper because of decisions made by this Administration.

First of all, in the high temperature, gas-cooled reactor program where for a number of years we have augmented and recently in cooperation with you supported HTGRs and now we are finding the Administration pulling out totally its support for this program.

The Mod-5 program, another area where cost sharing has been the hallmark where we have worked very carefully to maximize available resources, public and private, to move forward on wind energy. Again, you are pulling the rug out from under.

I see a failure to follow through on commitments we have made to the private sector in both those areas.

Secretary HERRINGTON. I think you have to differentiate. We have had to make some hard choices in the budget and I think you understand that. We have had to pick winners and losers. The two you mentioned are not high priority items on return for the amount of money that has been spent on them. It would be nice to continue those two programs, but you have to look at how long are you going to fund them, where is the market, who is going to buy them, and what are we going to do with them.

I think the two cases you mentioned are subject to criticism, both those projects.

Mr. FAZIO. One of the areas where we really made a lot of progress—I would agree with you, Mr. Chairman, has been made because of market rates for fossil fuels—is in the area of renewable energy. And I think we are on the edge of making breakthroughs in photovoltaics and wind power, but they are not afraid of putting up $5 million or $10 million opportunities to put up a market place. The Japanese will do it.

HTGR I think is one of the solutions—not the only one—but one of the solutions to the nuclear fission Mr. Myers talks about bringing down the cost of energy in the future. We shouldn't be myopic in thinking the current oil glut is not somewhat contrived. I think the Saudis are behind it.

I am not totally paranoid. But I am convinced that there is a need for this country to continue to pursue energy independence even in periods when it is easy to fall off our targets and to think only in terms of budget deficits.

I think the Department of Energy has made more than its share of contributions to deficit reduction, and certainly the results are

not particularly impressive as we see that deficit continuing to climb.

MIRROR FUSION TEST FACILITY

Let me touch on another area where I think we are penny wise and pound foolish. We have spent over $300 million for the tandem mirror fusion device at Livermore, and this year at the very point of completion, what do we have? A mothballing proposal in the budget, no use of that for any kind of experimentation whatsoever. What kind of investment strategy is that? It makes no sense to me.

We could have seen the deficits climbing several years ago and perhaps mothballed it before we spent a few hundred million more to finish it.

Secretary HERRINGTON. Gramm-Rudman came out last fall and the projects that you have mentioned I think are all related to deficit targets that we are required to meet.

Mr. FAZIO. I understand Gramm-Rudman very well. I sat on the conference committee to put it together.

PHOTOVOLTAICS

Secretary HERRINGTON. The Photovoltaics issue you bring up, I think, is a good one. Photovoltaics, I think, has a great future, and I think you will see some of that research in the budget. I think the SMUD project was one of the best we had until the cost of producing became too high.

Mr. FAZIO. I appreciate you saying that. I wish the Department had said it one time in one budget submission. We had to force you every time.

Secretary HERRINGTON. I understand that. But I think the photovoltaic research that came out of that project is going to be beneficial in the long run.

Mr. FAZIO. I agree.

Secretary HERRINGTON. We still have our projects on photovoltaic research going in this budget. The problem with the SMUD project is once it proved the concept, the government should have stepped out of it. That is why the Department turned it down every time. The District should have taken it over and completed it on their own.

Mr. FAZIO. We just saw that in the municipal utility as analogous to some of the private utilities. I think it will end up continuing to be a seminal project and one we can look back on with some pride.

DEFERRALS

I would like to concentrate in my last area, and I will put the rest in the record, on the subject that Mrs. Boggs touched on, and that is the deferral request for 1986. We are seeing in this Administration at this point a use of deferrals to terminate programs. These are clearly under the law rescissions, not deferrals. But everybody understands why it is being done, because with the Chadha decision on one-House veto by shifting rescissions, which obviously are harder to accomplish because Congress has to enact

them, to deferrals which are easy to accomplish now, because one House can frustrate the Congress in their effort to appeal to them.

We have seen a tremendous political shift to the Administration in terms of their ability to dictate to Congress what sort of appropriations process we will have. At the very time we are being pilloried for not agreeing to a 3 percent real increase in defense in the next fiscal year, the Administration is deferring and rescinding something in the neighborhood of $35 billion in appropriations that were just signed into law several months ago.

Now, what kind of equity and what kind of fairness and what kind of cooperative process is that? It doesn't add up to anything other than an attempt to dominate the congressional process of appropriation.

Why else would there be this coincidence of congressional initiatives in the solar programs of $16.6 million added to the budget, and $16.6 million deferred, or $1.9 million in electric energy systems added to the budget by Congress, and $1.9 million deferred by the Administration, or $7.2 million deferred in energy conservation after Congress' initiative of $7.2 million in energy conservation appropriations? You are simply cancelling everything we have added without any exception in those areas.

It is one thing to tell Congress that you don't want to support our proposals for appropriation; another thing to attempt to use what, in fact, is becoming a backdoor, line item veto, and now you are using it particularly where we can't even have our response in the context of deferrals determine a program, and there are a number of them.

I think Mrs. Boggs cited one. There is a 45-day time period where Congress can make a decision as to whether they want to ratify a deferral or not. You folks are making proposals that will clearly eliminate an agency before the Congress had had a chance to act. That has happened several times in the Department of Energy and the Department of Interior on energy-related programs.

I think it needs to be highlighted and underscored by every Member of Congress that this—that in a bipartisan sense there is a role for the appropriators in assuming the budget priorities at any given point in history.

Secretary HERRINGTON. Two things: Deferrals by law are effective the minute they come up. We have attempted to give more time for Congress to act under these deferrals in the energy budget. I think that is important.

Number two, the President has a duty to send the budget up as he would like to see it as the Chief Executive. I understand you are talking about a legal issue here on how deferrals are interpreted, but I think that he has an obligation to the country, just as you do, to put this budget into Congress as he wants to see it, and that is what is driving the deferrals.

There is no other reason about it. He just doesn't happen to agree with the priorities that have been set in some of these deferrals.

Mr. FAZIO. We are not back in a period where we saw impoundments, but we are very close to it. When the President wants to eliminate a program he needs to under the law submit a rescission,

not a deferral which has the effect of a rescission, thereby strengthening his hand.

I hope the Administration will voluntarily reclassify each one of these deferrals that have had the effect of terminating a program because I think you are doing a tremendous disservice to the appropriations process, to this committee, and I think to the kinds of protections the American people value in their Constitution.

We have as much responsibility to be able to respond to those concerns of the Executive as he does to submit that budget, and I don't deny that we won't confirm any of the deferrals, won't ratify the rescissions.

In the early going in this Administration, we went along with many of them, but we have never been treated as we have been in the last year. The numbers of deferrals and rescissions and absolute numbers in terms of dollars is way up, and the number of them that have been used for the improper purpose of terminating programs has increased markedly.

I didn't mean to direct all my frustration at you, Mr. Secretary. I think you are the person who has had to implement some policies that perhaps you would not implement had you a better budget to deal with.

On the other hand, I appreciate your willingness to say that these are not OMB decisions foisted on you; that many of them come from your Cabinet spot.

I am very troubled by what I think is the moral equivalent of surrender, if we want to go back and use James Earl Carter's much maligned statement about the moral equivalent of war in trying to deal with our energy independence issue.

We are really saying there is something wrong with government and we ought to back out of the solution of many of these problems. I think it is the short-term perspective that will come back to haunt us eventually.

Thank you, Mr. Chairman.

Secretary HERRINGTON. The only point I would like to make is, number one, the legal status of a deferral, whether it is or is not an impoundment, I think is something we both can speculate on, and we need to look into that. I can't tell you what my personal feeling is. Lawyers need to look at it.

FEDERAL INVOLVEMENT IN THE ENERGY FIELD

But what we are really saying by this budget to the government in the energy field is not surrender. It is, let the free market work to get the cheapest prices and the most energy to the most people, and don't try to manipulate or guide the winners and losers because every time the Federal Government does it we make a mistake.

Mr. FAZIO. I don't think we make a mistake every time. I think we make mistakes, and we did attempt to do too much in a panic atmosphere in the early Seventies in response to the tightening noose around our neck that OPEC provided us. We have learned through trial and error to modify a number of our programs, and I am just as big an advocate—maybe not quite—but just as big an

advocate of the marketplace. Give it most of the credit for energy conservation.

I would also like to say for the record, it was Mr. Carter who began the process of letting the marketplace work during the latter years of his administration. Most of the credit and the benefit politically and economically has accrued to this Administration because those policies over time eventually did provide for a marketplace environment for energy. They certainly have benefited, and as we look to the next several years will continue to on an energy crisis.

But I want to give credit to the man who fought the conventional wisdom in the country, and certainly his party, and went in the right direction.

Mrs. Boggs, would you like me to yield to you?

Mrs. BOGGS. If you would.

I just wanted to say, many of the programs you discussed, Mr. Secretary, that have given us great conservation measures and thereby more energy independence have been Federal initiatives and initiatives from your department and from this committee. So government is not always wrong.

Secretary HERRINGTON. I didn't say government is always wrong. I do take exception from an economic historical basis when government gets in and attempts to regulate things like petroleum prices, to regulate the price of natural gas and set supplies and prices in the market. I think that is a mistake, because you always end up not getting a clean bill but getting special preferences, winners and losers, That, to me, is not best for the economy.

Mr. FAZIO. That was a policy of people in both parties for an awfully long period of time. I tend to agree with your inclusion, but I also think we have a role in R&D and we have a role in providing commercialization, demonstration incentives.

I think we have to compete with the non-free international market in energy, too. We don't have a free market internationally in many things, and certainly not in energy. Those initiatives in nuclear fission that we see in Europe aren't efforts the Japanese are putting forth in photovoltaics, for example; they didn't just happen because of the market conditions. They have seen markets and decided to attack them, and they are doing it successfully for their own independence or for world dominance in exports.

Thank you, Mr. Chairman.

Mr. BEVILL. All right. The Chair recognizes Mr. Rudd.

Mr. RUDD. Thank you, Mr. Chairman.

Welcome to the Hill, Mr. Secretary. Let me just throw out a little philosophy of my own for a moment.

EXECUTIVE LEADERSHIP

I recognize that the President is charged constitutionally with providing leadership for our Nation, and that includes Congress. We obviously could not have 535 leaders telling us where to go, because we would never be going in the same direction. And our Founding Fathers, in their wisdom, recognized that after a trial and error with the Articles of Confederation which made us an extremely ineffective, unwieldy, unsuccessful nation which, if Eng-

land probably hadn't been busy with a number of other things, would have resulted in our demise.

So, that was one of the reasons for this great document that we live under, this guideline we live under, providing for assuring we would have that leadership. And if the President doesn't exercise the leadership, then we do end up in chaos, and we are unwieldy and we are weak, and all of the things that go with it.

SUPERCONDUCTING SUPER COLLIDER

But I have some concerns that I will just retrace for a moment over some of the subject matter that my colleague from California and friend from Indiana hit on for just a moment to get a little clarification. One of them has to do with the supercollider which we call desertron, because we understand probably the best location would be in the central Arizona desert for that magnificent bit of equipment since we have the room to do it and the ground is fairly soft for hole borers and that sort of thing.

I had to get that in there, Mr. Secretary.

Secretary HERRINGTON. I am sorry I didn't mention Arizona. They have been looking for that.

Mr. RUDD. The point is, we have spent a lot of money on R&D in this thing, so it isn't a matter of whether we go ahead with it or not for achievement. We have come to a point where something has to be done. We can R&D this thing all over the world and all over through time and everything else, but we have wasted everything if we don't start doing something about it, and that is what desertron is all about, in my mind, anyway.

So, let me ask you—you have already indicated that your priority does not include "desertron." So let me ask you, does the President support it?

Secretary HERRINGTON. I think I said my priority didn't include desertron.

You are quite correct; 42 States have expressed interest in this project. It is a super project.

Mr. MYERS. That means eight didn't?

Secretary HERRINGTON. Eight didn't.

The question is not whether our priorities are—it is whether we can afford it at this time. I think that is the only question.

Mr. RUDD. Well, I understand that, so we come down to priorities. But if—we know that we must have this energy to eventually survive, the way things are going, and as rapidly as they are going, and the way our enemy, the Soviet Union, is moving up and is about ready to engulf us with all of the things that they are doing. So, the point is that we can't do anything else logically except build it.

Even though you haven't provided or asked for funding in 1987, it is my understanding that the site is going to be selected some time this summer. So we must be going forward on it.

Is that true or not?

Secretary HERRINGTON. No. We have a study coming back this summer, but site selection is not contemplated for this year.

Mr. RUDD. Even so, I think we have to do something. There is an indication to say, well, maybe we could cut back from between 34

billion and $6 billion to do it, but I don't see how we can. You can't do it halfway. You might let part of it go and start building part of it, eventually slowing down the eventual process of having "desertron" in place, but I don't know whether that is possible or not, either.

Do you?

Secretary HERRINGTON. Well, we are looking at possibilities. Again, I said this summer we will have a report in on some of these questions that we are looking at, and if further research is necessary we have some money that we can spend on it if necessary. But I just don't think that—

Mr. RUDD. What I am saying, I guess, is would it be reasonable to build a quarter of that giant circle now and/or build it more slowly or do something like that?

Secretary HERRINGTON. On economy to scale, I would say no. That is the wrong way to go at a construction project. But, frankly, I can't give you the answer.

My guess is it would not be as economical to build part of it.

Mr. RUDD. I gather you agree it is extremely important and we have to do something about it. We just can't keep pouring money into R&D on it when we ought to be moving into the real thing.

Secretary HERRINGTON. Well, I think it is a very worthwhile project and it is a good project. But I don't want to misrepresent my position. I don't think we can afford it in this budget.

Mr. RUDD. Maybe we can never afford it then, and then everything we have done so far is wasted. I don't know the answer to that, either, but I am in favor of going ahead with it personally, and I hope we will go ahead with it.

COPPER CANISTERS

I, last year, asked that some inquiry and exploration be made with regard to the use of copper canisters in putting away low-level nuclear waste as disposal.

Can you give me an idea where that stands or whether the evaluation has been made?

Secretary HERRINGTON. We submitted a report in September on the copper canister issue. The report basically said we need to do more research in that area. You will see $3 million in the 1987 budget for that particular activity. It has promise.

Mr. RUDD. I thank you for that. If possible, could I get a copy of that report?

Secretary HERRINGTON. Yes. I will submit that for the record.

[The information has been retained in committee files.]

Mr. RUDD. Thank you.

NUCLEAR REGULATORY LEGISLATION

I was really very pleased to hear you talk about legislation with regard to the regulatory operation of nuclear energy. We desperately need something that will put this back in proper focus so that we can utilize nuclear energy; and with the better, smaller, less costly processes with which we now think we have then it becomes absolutely vital to do that.

You mentioned you had this legislation. Will that legislation call for that? Is there some way to urge the NRC to do something they should have been doing all along?

Secretary HERRINGTON. I think it calls for several things. Overall, I think it betters the process. It doesn't call specifically for what you are asking for. We would like to see more movement towards a simplified permit process. We would like to see movement towards standardization or modular type development, things like that, to make it easier, more economical.

There are other provisions in there.

Mr. RUDD. Well, do you feel that we do need some more stringent, more specific guidelines for NRC to move them ahead so that we can accomplish something in the nuclear energy field without waiting 14 or 15 years to get it done?

Secretary HERRINGTON. Yes.

Mr. RUDD. Will that legislation address itself in any way to that?

Secretary HERRINGTON. The point I overlooked, that I think may work towards what you are saying, which I think is a legitimate point that you have made, is the attempt to institutionalize a rational backfitting process that has long been needed. This bill does work in that direction, which is a major step in addition to the single permit. And the other things that I mentioned also help, but not to that extent.

One of our problems has been, in my estimation, the terrible expense of backfitting that has gone on.

Mr. RUDD. Terrible expense of?

Secretary HERRINGTON. Of backfitting that has gone on.

Mr. RUDD. OK.

Well, apparently we are headed in the right direction.

You said the bill was not—you didn't appear to be overly enthusiastic about the bill as a whole. What would you like to have us do in that bill that might make it more acceptable to you?

Secretary HERRINGTON. Well, I think enacting that bill will go a long way towards changing public attitudes and moving us in the right direction. There are a lot of other things we could talk about, but I don't know that they are realistic congressionally to be enacted.

What we have put forward is a bill we think can be adopted, and we think will help solve the problem. If that step is taken, I would be happy to try and get into the next step.

Mr. RUDD. Does the bill have a number?

Secretary HERRINGTON. Yes. It is H.R. 2488 and S. 2073.

Mr. RUDD. I haven't seen it yet and would like to get my hands on it, if I can.

PRIVATIZATION

One last area of concern. You indicated that in privatization of some of the agencies and functions under your jurisdiction that—I think you indicated that it would be two areas of the Naval Petroleum Reserve that might be eligible for privatization, and that we had plenty of petroleum and our Navy was no longer an oil Navy but it was a nuclear energy Navy and a gas engine turbine type Navy, and that sort of thing.

But I think we still have—we are still running on oil in all sorts of ways. And the Naval Petroleum Reserve, as you know, is a very emotional issue, because there are a number of people who feel that we can't depend on anybody else in time of war feeling that in wartime there is no way you can save money because that is a very wasteful operation; and if people need what they need in order to command Armys and Navys and Air Forces and Marine Corps, they have got to be able to move fast and sometimes spend huge quantities of money that will be forever wasted even to the extent that in peacetime, hoping that these engines of war will never be used.

But we have to spend a lot of money on them as a deterrence, so our enemy will not attack us knowing that we can retaliate or that we can defend ourselves.

NAVAL PETROLEUM RESERVE

So we do run on oil, and I for one would be very reluctant to agree to anything that would upset that Naval Petroleum Reserve in any way. And, as a matter of fact, I would want to make sure, along with what my colleague, Mr. Myers said, with oil prices being what they are, maybe we ought to at this time go ahead and do it despite the fact that we are under a dollar crunch and that sort of thing.

I guess you have already responded to that whole area, so I am not asking for a response. I just want to make sure that those ideas do hit the record so we know what we are working toward.

Secretary HERRINGTON. I would like to say one thing. A lot of us are Navy supporters. I am particularly one because I was Assistant Secretary of the Navy for a while. I don't see this as a threat to naval security, because we are selling oil out of the Naval Reserve today as a Federal activity.

Our income last year was $1.3 billion from sales. Eighty percent is owned by the government; 20 percent owned by Chevron and is managed by Bechtel Corporation under a large contract.

What I see is a declining value of that stream because we are now using more expensive recovery methods for enhanced oil recovery. I see that. I see income projections falling down to the area of half a billion dollars in 10 years. I don't think it is the asset that everyone thinks it is in the ground inactive waiting for an emergency. That is what the Strategic Petroleum Reserve is.

One of the Congressmen mentioned in a hearing the other day that maybe we ought to sell NPR and take the money and put more in SPR and fill it. The distribution function from SPR is far better than the NPR distribution. That is the only thing we are saying. We ought to look at how we can maximize our dollars.

Mr. RUDD. What I am saying is, I don't want to see the control of that given up to the private sector. I think it should remain with the government. That may sound like a socialist approach to this, but that is how I feel about it. I think we should never give that up. We can do with it whatever sort of agreements we might want to make with the private sector, but I want the last word to be with the government on that.

I certainly thank you for your direct and forthright answers today.

Thank you, Mr. Chairman. I have no other questions.

Mr. BEVILL. The Chair recognizes Mr. Watkins.

Mr. WATKINS. Thank you, Mr. Chairman.

Mr. Secretary, members of your staff, you were appointed by President Reagan recently? How long have you been onboard as Secretary?

Secretary HERRINGTON. One year.

Mr. WATKINS. One year.

I can assume the President is following your advice and counsel along the way on energy matters.

OIL IMPORT FEE

Have you advised him to place an export-import fee on oil?

Secretary HERRINGTON. I don't think my advice to the Administration is something that I want to go into in this hearing, because I think it is better for the internal process to work so that we are open and direct in private conferences.

Mr. WATKINS. Do you think an import tax fee should be recommended?

Secretary HERRINGTON. No.

Mr. WATKINS. You don't?

Secretary HERRINGTON. No. I think it is the Administration's policy that an import fee is not the best energy policy, the best industrial policy and the best economic policy. I think the President has said that in his statement, that there will be no new taxes.

Mr. WATKINS. Did you have any input on the President's proposal to do away with any tangible drilling cost following the advice of counsel on that and the depletion allowances?

Secretary HERRINGTON. I was in on the meetings and participated in discussions, yes. The same with the import fee.

If I could finish my answer on that, the President's discussion on import fee the other day showed an open mind insofar as it might be necessary to keep any tax reform revenue-neutral. That was the only statement that he made. I think the Administration does not favor an import fee.

Mr. WATKINS. Except maybe to make it revenue neutral?

Secretary HERRINGTON. Yes, on any tax reform.

Mr. WATKINS. I don't understand that logic, you know. I think he is going to raise your taxes but it is not going to increase because it is going to be revenue neutral.

POWER MARKETING ADMINISTRATION—PRIVATIZATION

Let me ask you this. Evidently you recommended the selling of the power marketing and evidently he accepted that as advocating that. That is in his budget.

Secretary HERRINGTON. We are supportive of that proposal.

Mr. WATKINS. Is the President?

Secretary HERRINGTON. It is his budget.

Mr. WATKINS. I just want to point out that that is going to increase, according to your testimony last year, with me, in my area

of the State of Oklahoma, the utility rates of my people will increase 82 percent.

Secretary HERRINGTON. I want to clarify that. Last year my testimony concerned the payback based on market rates of interest.

We did not discuss a sale last year and this year's payback proposal is at existing interest rates. I don't think this year's proposal would have that impact.

I would like to look at that but I don't think we are talking about anywhere near that kind of impact on utility rates in your area.

Mr. WATKINS. Well, we can't have it both ways. We are advocating a heavy tax increase by selling off the power marketing program and all the people in rural electric areas, can expect over $100 a month "tax" increase. That is what they can expect.

Now, you can't have it both ways. You can't say, well, we are going to cut the budget and not going to raise any taxes but you are going to tax, and I would like it to be on the record this is what is going to happen—is that they are going to have a hidden tax increase and if they do away with the rural electric programs, also, what is being proposed, they will have probably 100 percent increase at a time when the farmers out there on rural electric lines can't make it today.

So, Mr. Secretary, that is why I hope that you can take some advice and counsel down there to them that they are heading the wrong way.

Mr. Fazio, I don't know who you are looking at to purchase them; private utility companies? Have you thought about selling them off to the electric co-ops?

Secretary HERRINGTON. I think there are a number of possibilities, sir. I don't think we can tell just yet what the most advantageous sale would be for the customers and the businesses that are located there.

You have raised a very important point on the impact in your area and not only that, in the Bonneville area we must also consider the impact on the aluminum industry. Whatever we do, we would like to be very careful that we do not jeopardize how they do business and how they exist.

Under the repayment plan, which I want to differentiate from the plan to sell, in your area we estimate wholesale electric utility rates would probably rise 10 to 11 percent in the area.

Mr. WATKINS. Are you going to be able to come out with a factual statement on that before the proposed time or not?

Secretary HERRINGTON. I think we can.

Mr. WATKINS. We would like to have actual figures instead of something kind of cooked up.

Secretary HERRINGTON. I would like to supply it for the record.

Mr. WATKINS. I would appreciate it if you would.

[The information follows:]

SOUTHWESTERN POWER RATE IMPACTS

The rate reform proposal would have negligible impact on the Sam Rayburn Project rates, but would result in a 10–11 percent increase in the system-wide rates in fiscal year 1987 and approximately 3 percent additional increase in each of the succeeding 2 years for a total impact between 16–17 percent. The impact of South-

western's wholesale rates on the ultimate consumer would be less on a percentage basis because of markup from wholesale to retail and the fact that Southwestern's distribution utility customers obtain varying amounts of their total supply from the Federal System.

FEDERAL ENERGY REGULATORY COMMISSION

Mr. WATKINS. Mr. Secretary, you also have FERC in DOE and we fund FERC here. You have certain responsibility over FERC I imagine. Is that true?

Secretary HERRINGTON. Well, I am not sure we do. It is listed in the Department of Energy under the organizational chart but as far as exercising jurisdiction over FERC, I would say the answer is no.

It is an independent agency and we do not have any control or attempt to have any control over it. Their budget is in our budget.

Mr. WATKINS. But you don't do any—they will be coming before our committee and I will be asking them the same thing. We have been trying to get them to act on some hydropower licensing problems.

I know you are concerned about bureaucracies. I don't know if you have anything to do about that or not within FERC.

Secretary HERRINGTON. Not with FERC, sir. We file our comments in front of FERC like everybody else in the government, and we have no special relationship with FERC.

Mr. WATKINS. Basically, we are the only ones who have any basic direct relationship. If they are sitting there, we fund you, the money goes to you and DOE and goes down to FERC and everybody gets it.

Is that what it is?

Secretary HERRINGTON. Basically, sir, that is the budgetary cycle.

Mr. WATKINS. I will discuss that with them when they come back up.

TECHNOLOGY TRANSFER

I am interested in technology transfer. I won't take any more time except to encourage you—how much money are you asking for this year in technology transfer?

Secretary HERRINGTON. Sir, it is a crosscutting figure across many different parts of the budget. I would like to submit it for the record if I could rather than guess at it.

[The information follows:]

TECHNOLOGY TRANSFER

Technology transfer is an integral and essential part of all the DOE R&D programs. These activities include written materials, symposia, workshops, patent licensing, etc. The Department is not in the business of employing the technologies we are exploring, rather the information is passed to the private sector for their use. The actual amount the Department is spending on this activity is not readily available, however, as it is woven into each of the program efforts and is not separately identified.

A few of the technology transfer type activities can easily be identified from the budget. I can report that in FY 1987 we have $2.0 million for Solar Energy technology transfer and a $14.7 million program level for operation of the Technical Information Center, which is an information distribution service for all our program areas.

Mr. WATKINS. I would like to encourage you to make it a priority.

If not, I won't discuss it, Mr. Secretary, as being a priority because if technology transfer is only being paid lip service most of the time I think it has got to have some very personal attention if it is going to have some effect.

Secretary HERRINGTON. I think you have raised a good point. Some of the things I was referring to on a priority basis were patent policy and how we transfer technology to the private sector. Those are not budgetary items. It is how we do business.

That is why I am a little unprepared to say the number but there is money in there and I would like to give you a crosscutting figure for the record. It is an important area.

Mr. WATKINS. Thank you, Mr. Secretary. I don't have any other questions.

Mr. BEVILL. All right. The Chair recognizes Mr. Boner.

Mr. BONER. Mr. Secretary, I represent the 5th District in a State I am sure you are familiar with to some extent, Tennessee.

Secretary HERRINGTON. Yes, sir.

MONITORED RETRIEVABLE STORAGE

Mr. BONER. Would you tell me where you understand, from your perspective, DOE is with the proposal of the MRS and what you see happening in the near future as far as DOE is concerned.

Secretary HERRINGTON. As of the time we are sitting here, we are waiting on the court to act. We are under a court order and we cannot forward the proposal to Congress.

Mr. BONER. Are you aware or have you been told that the Governor might have another site in Tennessee besides the country riverside?

Secretary HERRINGTON. I have had those discussions with the Governor and I am not aware of the specific site, but I have had that conversation.

Mr. BONER. How does the delaying of the presentation to Congress affect the $46 million of the nuclear waste fund that is earmarked for MRS?

Secretary HERRINGTON. Our feeling is it will not affect it at all; that is for the 1987 budget. If we get it, the program will be on track.

Mr. BONER. Before I go to my next question, let me say that we had a public hearing in Nashville and representative of DOE, Ben Rusche, did an outstanding job of communicating with the people there in handling all the situations that came about as a result of that hearing. He should be complimented.

I don't know if you are going to give him a raise or not, but he said if you did I would get part of it.

Secretary HERRINGTON. I agree with you that Mr. Rusche is an outstanding individual with the difficult program he is handling.

TENNESSEE VALLEY AUTHORITY—PRIVATIZATION

Mr. BONER. Mr. Secretary, the Administration has proposed to sell or privatize the Power Marketing Administrations on the

grounds their utility's functions are not Federal in nature. At the same time, they deny any intent to de-privatize or sell the TVA.

I am glad that OMB or someone has seen the wisdom of not selling TVA and I fail to see the essential difference between its utility functions and that of the PMA.

Can you explain that difference?

Secretary HERRINGTON. Mr. Boner, you are correct that the Tennessee Valley Authority is not included in the DOE proposals for privatization. TVA is not a part of the Department of Energy. Your question could probably best be answered by either TVA or the Office of Management and Budget.

Mr. BONER. Occasionally, rumors are spread about TVA. I can assume the Department of Energy has no effort afoot to sell off the Tennessee Valley Authority.

Secretary HERRINGTON. I don't think it is ours to sell. That is one of the main points I would like to make.

Mr. BONER. Do you agree that the sale of the PMA's would result in, among other things, these non-Federal entities being subject to regional control?

Secretary HERRINGTON. Yes. I think that is a legitimate statement.

REGIONAL CONTROL OF UTILITIES

Mr. BONER. From your perspective, how would you define regional control and why would you say that is better if unfortunately it is better?

Secretary HERRINGTON. Well, I think issues of a local nature need to be decided at the local level. I have always been a strong believer in that.

I have been in business for 20 years before I came to government and I have been on local school boards. I like to make decisions in the community where I live and not have them dictated from Washington.

I think we could become more efficient in some of these operations and that we could probably be more responsive to the needs.

Mr. BONER. Would you want to apply that philosophy to the MRS site in Tennessee? Is that an unfair question?

Secretary HERRINGTON. No, it is a fair question. That waste issue is a very difficult issue.

Mr. BONER. Mr. Secretary, you may think it is difficult but you don't know how difficult it is until you go back home and listen to some of the people in their discussions.

MAGNETIC FUSION

Last year the President endorsed magnetic fusion at the Summit. In light of that and what appears to be a strong international interest and collaboration in fusion research, why are we seeing a cut in the budget in the fusion budget aside from the effects of Gramm-Rudman?

Secretary HERRINGTON. I think you are seeing one thing that is important and that is the Department of Energy choosing between two technologies that were being funded at equal levels, one technology, the Tokamak, I think, has ended up a winner and less de-

sirable would be the mirror fusion that was brought up a second ago.

I think we have been forced to make a choice between the two and based on the best scientific evaluation we could get, we have made the choice. To lower funding on both and not move forward as fast I think might not be as good a policy.

I know people differ on this but we have done the best we can on this.

Mr. BONER. I have one other question that I wanted to ask and it is in the form of a statement, too, so I am going to read this for the record and then ask a question.

PROPOSED REGULATIONS FOR CONTRACTORS

I am interested in the proposed regulations which purport to implement Section 1534 of the fiscal year 1986 DOD authorization. To some extent, it disturbs me.

As I read them they would substantially impair the committee's ability to do its job. It appears to me that at least three major problems arise: scientists and technical experts at DOE national laboratories would be unable to respond to Congressional requests for briefings on research programs and technical issues. Costs associated with such briefings would be an unallowable expense against a contract.

The other area that I have a concern is the members of Congress and staff would be limited to formal Congressional hearings for the purpose of discussing research programs under way at the national laboratories including the collection and sensitive research related to our national security.

Third and lastly, costs associated with the legislative liaison work including analyses of legislation and its effects upon the laboratory would also be disallowed. Such analysis, particularly if conducted in response to a Congressional or DOE request, could directly or indirectly affect the legislation which under the proposed regulation is an unallowable activity.

Clearly, in my opinion, this was not the intent of Congress.

Can you state for the record that these problems are not the intentions of DOE and could you work with the interested members of Congress in modifying what could be some confusing language?

Secretary HERRINGTON. I don't think the section 1534 regulation changes the existing situation at least in intent. We do not mean it to.

What we would like to do is strike a balance between keeping the scientific program directors fully accessible to the Congress as they should be for briefings, for talks, for meetings; on the other hand, restrict, if we can, activity of lobbying for specific programs by specific program sponsors outside of Department of Energy control where we are not able to know what is going on. It makes the process very difficult.

I would like to have our Assistant Secretary for Management and Administration, Martha Hesse, come up and brief any of you on how this could work or what our intent is, if possible, and try to be as responsive to you as we can.

We do not want to create an unworkable situation. That is not our main goal.

JOB ASSISTANCE AT OAK RIDGE

Mr. BONER. Lastly, while I do not have any specific questions on this point, I think you would agree Oak Ridge has suffered considerably over the last couple of years and I just wanted you to be aware I will be working very hard with Congressman Marilyn Lloyd to find ways for us to try to maximize the technical expertise and facilities at Oak Ridge. In that respect, there have been layoffs as a result of some of the decisions that were made.

Is the Department of Energy doing anything to help transfer these people into other jobs, to retrain any of these people? Are they doing anything in job assistance, help like that?

Secretary HERRINGTON. Yes. We have several programs we have been working on with contractors down there, and also with the people at Oak Ridge. I want you to understand that we consider that work base and those people an asset to our operations and to the national interest.

We do not want to upset or jeopardize in any way that type of a work base. Although we have had to make some budgetary decisions on certain projects, we want to minimize that impact and we will work with you and Mrs. Lloyd in every way we can.

Mr. BONER. Thank you, Mr. Secretary.

Thank you, Mr. Chairman.

Mr. BEVILL. Any other questions?

Mr. MYERS. Mr. Conte is trying to get here.

Mr. WATKINS. I have a couple of questions.

Mr. MYERS. He will have some questions for the record if he doesn't get here.

FUNDS SPENT IN FOREIGN COUNTRIES

Mr. WATKINS. Mr. Secretary, I wanted to wait to ask these particular questions until everyone else had the opportunity to question you. I have been quite concerned about how much money is being spent overseas in foreign countries.

What foreign countries are you involved in and spending money in as the Department of Energy?

Secretary HERRINGTON. We did a crosscut on this figure. It is our estimate today that we are spending approximately $456 million on various international transactions. Foreign work coming into our Department from overseas, other governments that we are doing for in other countries, amounts to approximately $661 million. So it is a net gain as we see it.

Mr. WATKINS. Would you list for the record what countries we are spending money in and how much and what purpose?

Secretary HERRINGTON. We could submit that for the record, please.

Mr. WATKINS. I would appreciate it if you would.

Also, what we are doing over there.

Secretary HERRINGTON. Yes, sir.

Mr. WATKINS. I would like to know what authorizations have granted the involvement in each of these areas.

[The information follows:]

FUNDS SPENT OVERSEAS

The Department of Energy's authorization for research and development work being performed overseas is found in Section 107 of the Energy Reorganization Act of 1974 and in Section 301 of the Energy and Water Development Appropriation Act for FY 1986. Currently three Department of Energy officials are detailed overseas in Tokyo, Paris, and Vienna. A list of countries in which U.S. funds are being spent oversea, and a brief description of the work being performed, will be provided to the Committee separately upon receipt of data being obtained from the Department's field offices and contractors.

FOREIGN TRAVEL EXPENDITURES

Mr. WATKINS. How many people do you have overseas, a rough estimate?

Secretary HERRINGTON. I would say three or four is what we can think of right now. We do travel overseas, but three or four are based there permanently.

Mr. WATKINS. How much do we spend on traveling overseas and where is our most active area that we are traveling out of the Department of Energy?

Secretary HERRINGTON. Well, I know two important areas. I don't know which one is more active.

One is the International Energy Agency in Europe. We do have a lot of cooperation with European countries such as France.

I have a figure of $45 million that we spent. We also do a great deal of work with Japan, China in attempts to sell hydro, nuclear, and coal production technology, that type of thing.

HYDROPOWER

Mr. WATKINS. What are you doing over in China and elsewhere with hydropower?

Secretary HERRINGTON. One that comes to mind obviously is we are working on the possible contracts by American business for three gorges which is a $20 billion project for probably the largest hydroelectric project in the world.

Mr. WATKINS. Do you think hydropower is important in this country?

Secretary HERRINGTON. Oh, yes. In this country, yes.

Mr. WATKINS. Why isn't the Administration pushing for hydroelectric power development in the United States?

I have been working with the Corps of Engineers for six years on some hydropower projects and can't get them to do anything. They spend all the money back and forth going overseas trying to get hydropower to go over there.

Secretary HERRINGTON. We are not spending any money in China for development of hydropower. We are working with consultants and studying feasibilities to see if we can get those contracts for American business.

Mr. WATKINS. I thought you spent that money for travel?

Secretary HERRINGTON. There is travel money, yes.

Mr. FAZIO. You are helping the marketplace.

Mr. WATKINS. You are kind of contradictory here. When you think it is important in one way, you run off and do all that to try

to enhance the market, but you are not willing to have Southwest Power Administration and Bonneville and others as government assist the marketing in our country and helping build our tax base and helping build the necessary revenue to help us do the job here.

FOREIGN TRAVEL

Mr. Chairman, I want to find out some more information about how we are spending American taxpayer dollars going overseas on junkets. I just want some reports on that.

Thank you, Mr. Chairman.

Secretary HERRINGTON. I might have confused you a little. The $45 million is not just in China. It is the overall travel budget for the Department of Energy. We have a lot of activities, defense oriented, in cooperation, international cooperation.

Mr. WATKINS. Forty-five million dollars travel budget?

Secretary HERRINGTON. For DOE and all of our contractors, which are considerable.

Mr. MYERS. Is that domestic and foreign?

Secretary HERRINGTON. Yes.

Mr. MYERS. That is domestic as well?

Mr. WATKINS. Could you break that down? Would you tell us how much you spend overseas, rough estimate?

Secretary HERRINGTON. We will be happy to do that.

[The information follows:]

FOREIGN TRAVEL

The Department of Energy spends about 11.5 million dollars a year on foreign travel. Approximately 20% of these funds are expended on federal employee travel with the remainder on contractor travel. The Federal Republic of Germany was the most frequently visited country in 1985 accounting for approximately 20% of all DOE funded trips.

HYDROPOWER

Secretary HERRINGTON. Now, on the hydropower, we have since the late 1970s spent $70 million on American hydropower development in the Department. I don't know if that counts what we have spent at Bonneville and others, but that is in our DOE budget.

I would like to give that for the record, too.

Mr. WATKINS. I would like that, and how much you spent overseas in trying to enhance hydropower there and I would like to know where that travel has been overseas.

Secretary HERRINGTON. I think very little hydro overseas. It won't be much.

Mr. WATKINS. If you have got any you have more than what I have got down in my part of the country. I want to find out. My folks need to know.

I am going to take them not first-class, maybe second-class, but we have to try to help them raise their economy.

Eight out of 20 counties in my district have a lower per capita income than the people in Hong Kong.

Mr. BONER. Would you want a monitored retrievable storage site in your area? I might be able to get it for you.

Mr. WATKINS. But all my counties in my district, every last one of them have lower per capita income than Japan, yet we are doing all of these things great for Japan and Hong Kong.

I just want to get on the record that I am concerned about how we are spending money down at the Department of Energy on foreign travel, foreign junkets around the country.

Thank you, Mr. Chairman.

Mr. BEVILL. The Chair recognizes Mrs. Boggs.

Mrs. BOGGS. Thank you.

Mr. Secretary, you have been the secretary now for a year or so and I know that you have some very fine background in this regard.

EMPLOYMENT OF WOMEN AND MINORITIES

But would you please give me a summary of the progress you have made on the hiring and promotion of women and minorities for technical and management positions in the Department?

Secretary HERRINGTON. Well, our Department of Energy leads the government in presidential appointees. We are better than any other department in the government.

We have three assistant secretaries who are women: Mary Walker, Donna Fitzpatrick, Martha Hesse. We have women in management positions at every level, including our chief of litigation.

I will be willing to stack up our record against any other governmental department that can be named.

Mrs. BOGGS. And minorities as well?

Secretary HERRINGTON. Yes. The third ranking, actually today the second and third-ranking administrators in the Department of Energy are Hispanics. Danny Boggs and Joseph Salgado, who is Under Secretary, Danny's Deputy Secretary and we have a good record in minorities, women and I think compared against any other agencies, you will find it quite satisfactory.

TECHNOLOGY TRANSFER

Mrs. BOGGS. If I may, Mr. Chairman, just make a comment.

I am very pleased at the progress you are making in the technology transfer area. That is something that has concerned several members of this committee for a long time, that somehow our private sector doesn't get in in time to go forward with the development and the transfer of technology to the kinds of distribution in management, production that some of our colleagues in other countries seem to be able to take, that our government has been able to finance and put it into the marketplace a lot more quickly than we have been able to.

I think working with the various laboratories and with the other institutions and colleges and universities in those regards is a splendid development. I congratulate you.

ENVIRONMENT, SAFETY AND HEALTH

I was wondering in the environmental and safety and health programs where you have a 9 percent increase in long-term research

effort, are you also addressing some of the practical situations that occur such as could occur in the terrorist attack or in the hurricanes and other natural disasters, and there is some manmade disasters such as explosions.

Secretary HERRINGTON. Yes. We have been concentrating in our safeguards and securities on the type of activity that you mentioned.

I think you also see an increase in remedial action in our budget besides the one area that you mentioned.

Mrs. BOGGS. Have you been cooperating actively with industry and with FEMA in these regards?

Secretary HERRINGTON. I feel that we have. We can always do better, but I feel we have been making good efforts in that area.

Mrs. BOGGS. That includes not only accidents that occur, but also in, sometimes the carelessness of actual dumping of pollutants and so on.

Has that been a concern of the Department as well?

Secretary HERRINGTON. Yes.

Mrs. BOGGS. Thank you, Mr. Chairman.

Mr. FAZIO. Mr. Chairman, is Mr. Conte still on his way?

Mr. BEVILL. He has submitted his questions for the record. He has several questions he wanted to ask in person, but he could not get here. He submitted them.

As a matter of fact, each of us have questions we will submit to be answered on the record, Mr. Secretary.

Talking about our Power Marketing Administrations, each member of this committee is very interested in your recommendation, and the President's recommendation, and certainly we will be considering that. However, as you know, that will be handled by the Energy and Commerce and the Interior Committees. I am sure you are making those recommendations to them, too.

Secretary HERRINGTON. Yes, sir.

Mr. BEVILL. We appreciate you giving us the benefit of your thinking on that also, because we are interested.

We appreciate the good work you are doing and we are looking forward to hearing from each of your assistants that will be testifying and we are going to be asking a lot of questions of them of course. We appreciate the job you are doing and the management you have.

I have served with five Presidents. We have never adopted all of their recommendations, but we do consider every one of them and that is all you could ask, isn't it?

Secretary HERRINGTON. Yes, sir.

Mr. BEVILL. We appreciate you very much and, Martha, we appreciate the help you have been giving us and the staff. You have been very helpful to us.

If there are no further questions, then, we will all submit questions for the record.

We stand adjourned until 10:00 in the morning.

[The following questions and answers were provided for inclusion in the record:]

PROGRAM OVERVIEW

Mr. Bevill. Mr. Secretary, also during last year's testimony you said: "Good times are a good time to prepare for the future. . . . I think now is the time to focus on the future. . . and focus on energy security for this country." Do you still agree with that view and how does your FY 1987 budget request reflect that position?

Secretary Herrington. The Department of Energy's FY 1987 budget represents a sound energy policy which also meets requirements to limit Department expenditures due to Gramm-Rudman. The Strategic Petroleum Reserve currently contains approximately 500 million barrels. This level of reserves would provide for 120 days of undiminished U.S. oil consumption during an oil supply emergency. This is the same level of security which Congress had planned for in the late 1970's when the 750 million barrel target was established. In addition, the dramatic increase in non OPEC production and improvement in the world oil market since the 1970's does not suggest that the SPR should be increased now. Therefore, our FY 1987 budget request does provide for our future oil security in light of the substantial additions to the Strategic Petroleum Reserve that have been made over the last five years and greater stability in the world oil market. We will continue to analyze oil market conditions and, if necessary, recommend measures to ensure that our energy security is not threatened. Finally and importantly, we are proposing decontrol of the wellhead price of natural gas. Decontrol has proven successful in oil markets and we would expect similar results if gas is decontrolled. With energy prices down, it is an excellent time to decontrol. We hope to persuade Congress that rather than increase federal energy spending, we need to eliminate counter-productive energy regulations.

RELATIONS WITH CONGRESS

Mr. Bevill. Mr. Secretary, the system of government we have relies necessarily on cooperation and compromise, particularly between the Executive and Legislative branches. Do you now and do you intend in the future to rely on the give and take and mutual compromise necessary to meet the Administration's priorities and the priorities of the congress?

Secretary Herrington. The Department values a good working relationship with the Congress. Our priorities do not differ on ends, but only on means. Both the Administration and Congress recognize the importance of deficit reduction--witness the bipartisan support for Gramm-Rudman--so our differences really revolve around how best to go about achieving this desirable goal. The Department has shown a spirit of compromise in the recent decision to withdraw certain deferrals in favor of rescissions. I think you will always find the Department of Energy cooperative and respectful of Congressional points of view.

PROGRAM OVERVIEW

Mr. Bevill. Mr. Secretary, your budget request has large increases for environmental cleanup of the Department of Energy facilities and safeguards and security. Are these your personal priorities and if so, why?

Secretary Herrington. As I have stated in my Environmental Policy Statement, it is the policy of the Department of Energy to conduct its operations in any environmentally safe and sound manner. While the record of the Department in this areas has generally been a good one, I want to be certain that this Department looks ahead to the many challenges of the future with a strong and aggressive program in place to meet our commitments to a clean environment, public health and safety. The environmental problems we are finding now at the Department's facilities are, for the most part, "legacies of the past," from activities conducted in a different atmosphere and under different standards than today's. Some of our facilities have been in use for nearly 40 years and we have learned a great deal about handling hazardous activities. What was acceptable in 1945 is not acceptable in 1986. In order to meet these more stringent standards, I am requesting these increases. Our budget also includes funding for the Environmental Survey, which is a one-time, baseline survey of all of the Department's facilities for all media; air, water, and soil. This survey will identify and prioritize areas of existing environmental risk. The Survey, which is in addition to ongoing environmental clean-ups, is critical in identifying a framework for addressing future environmental requirements. It is one of my personal priorities to ensure the Department of Energy is dedicated to correcting existing environmental problems and

establishing a framework for addressing environmental problems in the future.

The safeguards and security program for DOE facilities is also one of my top personal priorities. United States nuclear weapons research, production, and storage facilities and processes require special protection and executive oversight because of their significance to national security. Grave consequences would follow theft, loss, or unauthorized action involving nuclear weapons, special nuclear material, or classified material. Because of this, shortly after I became Secretary of Energy, I commissioned a study team to conduct an independent assessment that would thoroughly examine the adequacy, effectiveness, and management of all phases of the current program as well as existing or proposed plans for safeguards and security improvements. The report of this team indicated that any adversary who attempts to gain control over or steal a nuclear weapon, a critical weapon component, or special nuclear material would face a high probability of failure. The recommendations of the study are currently being implemented.

Over the past few years we have been involved in a concentrated effort to upgrade the safeguards and security of our facilities and materials with an accompanying increase in funding requirements. However, in FY 1987 the budget increase for these activities is not substantial because we are now completing many of our capital improvements and beginning to see the results of our efforts.

International Cooperation

Mr. Bevill. Many of the activities of the Department of Energy involving magnetic fusion, high energy physics and nuclear fission offer opportunities for international collaboration. What has been done in the past year to assure that the U.S. and other countries cooperate in energy research?

Secretary Herrington. Considerable progress in promoting and achieving international collaboration in magnetic fusion was made in 1985. Under the auspices of the International Energy Agency (IEA) of the OECD, the Fusion Power Coordinating Committee saw three agreements signed in 1986. One agreement makes possible the collaborative investigation of toroidal physics in, and plasma technologies of, tokamaks with poloidal-field divertors by exploiting the capabilities of the ASDEX-Upgrade Tokamak at the Max Planck Institute for Plasma Physics near Munich. Another agreement was signed for coordination of work on the stellarator concept between DOE and Euratom; the Japanese are expected to join this agreement some time in the future. The third agreement concluded was for cooperation among the three large tokamak facilities in the US, Japan and Europe, namely the TFTR, JT-60 and JET. Under the Economic Summit Working Group on Fusion, senior R&D policy officials from the members of the Economic Summit sought ways to stimulate increased collaboration through the coordination of fusion R&D policies. DOE also has an active bilateral cooperative program with Japan, and is concluding its negotiations with Euratom on a bilateral agreement. There is also a exchange program with the Soviet Union under the US-USSR Atomic Energy

Agreement which is concerned primarily with discussions of basic physics issues in fusion research.

DOE is using the Economic Summit Working Group in High Energy Physics to explore the role international collaboration is to play in potential new major facilities such as the Superconducting Super Collider (SSC). Under the US-Japan High Energy Physics Agreement, a working group has been set up to plan the future of collaborative activities including the possibilities of SSC collaboration at the design, R&D, construction and experimental levels and future possibilities at Japan's TRISTAN accelerator. Except for the scientific activities in the area of fundamental properties of matter that are agreed to annually under the US-USSR Atomic Energy Agreement, most international collaborations in high energy physics are developed on a more informal -- but no less effective -- basis from scientists-to-scientist's discussions. Such discussions have lead to major cost sharing ventures, such as the US-Japan-Italy collaboration on the Collider Detector Facility built for the Tevatron at Fermi National Accelerator Laboratory. This facility was dedicated during the past year.

In order to expand the effective collaboration which takes place under the Liquid Metal Fast Breeder Reactor Agreement with Japan, DOE sent a senior-level Task Force to Japan to discuss further ways in which the two programs could, by working together more closely, make better use of their existing nuclear R&D resources. Similar discussions were also held in Europe about enhanced collaboration in Advanced Reactors, and these will continue in 1986. The fission reactor R&D program has agreements in place with a value of over $40 million in foreign contributions for cooperative work. We expect to maintain this level of cooperation and to expand, where we can, in the areas of breeder design and breeder operating experience because breeder demonstration has been deferred in the U.S. for a time.

INTERNATIONAL COOPERATION

Mr. Bevill. Provide for the record a list of all funds, personnel, equipment and support provided to any foreign country during FY 1985, FY 1986, and planned for FY 1987, by appropriation. Explain the reason for each of these.

Secretary Herrington. An estimate of all funds, personnel, equipment and support provided to foreign countries during FY 1985, FY 1986, and planned for FY 1987, by appropriation, will be provided to the Committee separately upon receipt of data being obtained from the Department's field offices and contractors.

INTERNATIONAL COOPERATION

Mr. Bevill. Provide a list of all funds, personnel, equipment and other support provided to U.S. Department of Energy activities in FY 1985, FY 1986 and planned for FY 1987.

Secretary Herrington. An estimate of all funds, personnel, equipment and other support provided to U.S. Department of Energy activities by foreign countries in FY 1985, FY 1986 and planned for FY 1987 will be provided to the Committee separately upon receipt of data being obtained from the Department's field offices and contractors.

MANAGEMENT INITIATIVES

Mr. Bevill. The fiscal year 1986 budget assumed significant savings can be achieved by various improvements to management, governmental efficiency and cost effectiveness. Yet the FY 1987 budget request makes no mention of these management initiatives. Why?

Secretary Herrington. The Departmental management initiatives are included in the Program Levels requested in the FY 1987 budget, but this year were not included in specific tables or narratives.

Mr. Bevill. To what extent does the FY 1987 budget assume savings, either identified or not, from management improvements?

Secretary Herrington. The FY 1987 budget assumes savings of $107.0 million for FY 1985, $169.6 million for FY 1986 and $190.2 million for FY 1987 for management initiatives. These savings were included in the Program Levels requested in the budget submission.

Mr. Bevill. Describe the results and accomplishments of the Department's management initiatives in FY 1985 and FY 1986.

Secretary Herrington. The FY 1986 targeted savings of $169.6 million are currently on schedule and the Department is confident it will meet its goal. In FY 1985 the Department saved $107.0 million due to management initiatives. Some examples of these savings include: management of cash flow and deobligation of prior year funds, procedural reforms in organization planning, ADP, procurement, financial management and personnel and payroll processes, reduction of micromanagement of contractors, A-76/Productivity Reviews, increased Inspector General audit activity resulting in increased savings, improved efficiencies in administrative staffing, and improved staffing ratios for Personnel Offices.

REVENUES

Mr. Bevill. Provide for the record a list of all sources of revenue the Department has and the amounts derived from each in FY 1985, FY 1986, and FY 1987.

Secretary Herrington. Mr. Chairman, in fiscal year 1985 the Department collected over $5 billion in revenues. We estimate $3.8 billion will be collected in fiscal year 1986 and $4.9 billion in 1987. I will provide for the record a breakout, by program, of these revenues.

(the information follows:)

DEPARTMENT OF ENERGY
FY 1987 BUDGET
REVENUES
(Dollars in Thousands)

SOURCE	FY 1985	FY 1986	FY 1987
Proprietary Receipts:			
Uranium Enrichment	$1,410,936	$1,360,600	$1,286,400
Departmental Administration	225,635	244,228	251,947
Federal Energy Regulatory Commission	42,761	49,470	78,754
Naval Petroleum Reserves	846,038	831,152	1,011,809
Power Marketing Administrations:			
Alaska	6,541	7,887	8,573
Bonneville	111,050	114,200	118,300
Southeastern	79,420	108,685	117,364
Southwestern	107,488	93,400	94,600
Western	317,798	358,055	351,345
Subtotal, PMA's	622,297	682,227	690,182
Nuclear Waste Fund	1,721,011	498,900	538,000
Miscellaneous	---	10,500	6,600
Advances for Cooperative Work	136,967	125,044	86,450
Subtotal, Proprietary Receipts	$5,005,645	$3,802,121	$3,950,142
Proposed for Later Transmittal Under Proposed Legislation:			
Privatization:			
Naval Petroleum Reserves	---	---	80,150
Naval Petroleum Reserves - Proprietary Receipts (Loss)	---	---	-505,905
Sale of the Naval Petroleum Reserves	---	---	1,200,000
Subtotal, Privatization	---	---	774,245
Power Marketing Repayment Reform	---	---	161,709
Total, Department of Energy	$5,005,645	$3,802,121	$4,886,096

REVENUES

Mr. Bevill. What efforts will be made to increase revenues in FY 1987?

Secretary Herrington. The Department plans to increase revenues by taking action in two areas: First, the Department has proposed the sale of Naval Petroleum Reserves Nos. 1 and 3. The reserves were estimated to be worth approximately $3 to $5 billion. A mid-range of $3.6 billion has been distributed between FY 1987 ($1.2 billion) and FY 1988 ($2.4 billion) in the President's budget. These numbers will be revised based on the actual selling price and terms of sale. The principal basis for the sale price of the reserves will be the projected value of the oil reserves which also include significant quantities of natural gas liquids.

Second, the Administration's proposal to modify the Power Marketing Administration's repayment practices will increase revenues by $162 million in FY 1987. The legislative proposal would impose a fifty year or useful life straight line amortization schedule. Any new appropriated investment would carry an interest rate equal to the Treasury's current cost of borrowing. The Department is also pursuing a more aggressive application of DOE's full cost recovery policy for goods and services provided to non-DOE customers in the Cost of Work/Revenue program.

Reprogrammings

Mr. Bevill. Provide for the record a summary explanation and justification for each reprogramming request made to the Committee in FY 1985 and 1986 to date.

Secretary Herrington. The explanation and justification for each reprogramming request made in FY 1985 and 1986 to date is provided for the record.

(The information follows:)

Summary Explanation and Justification
for Reprogramming Requests

FY 1985

- An appropriation transfer of $16,071,000 from Uranium Supply and Enrichment Activities to the Geothermal Resources Development Fund was completed. This transfer provides the funds necessary to allow the Department of Energy to meet the financial obligations associated with the CU-1 Venture default. This action was concurred in by the Senate Appropriations Subcommittee on October 17, 1984 and the House Appropriations Subcommittee on October 18, 1984.

- A reprogramming within the Atomic Energy Defense Activities appropriation was completed. The reprogramming provides funding to make adjustments within the appropriation for urgent requirements in the Materials Production, Weapons Activities, and Verification and Control Technology programs. This action was concurred in by the House Appropriations Subcommittee on October 4, 1984 and the Senate Appropriations Subcommittee on November 19, 1984.

- A reprogramming within the Atomic Energy Defense Activities appropriation was completed. $15,000,000 was reprogrammed from Reactor Operations operating expenses to project 81-D-141, the L Reactor Upgrade, Savannah River, South Carolina. This action was necessary to permit the continued construction of a 1,000 acre cooling lake for the L Reactor. The reprogramming was concurred in by the Senate Appropriations Subcommittee on November 9, 1984, and by the House Appropriations Subcommittee on December 10, 1984.

- A reprogramming within the Atomic Energy Defense Activities appropriation was completed. $3,280,000 was reprogrammed from Production and Surveillance operating expenses to project 82-D-146, the Weapons Production and Production Support Facilities, various locations, providing funding for the acquisition of Precision Forge as a subproject. This action was concurred in by the House Appropriations Subcommittee on December 10, 1984, and by the Senate Appropriations Subcommittee on December 19, 1984.

- A reprogramming within the Energy Supply Research and Development Activities appropriation was completed. $7,400,000 of prior year unobligated balances was reprogrammed to provide $1,500,000 for Gas Cooled Spent Fuel Technology, $2,000,000 for Fenton Hill Hot Dry Rock as directed by Congress, and $3,900,000 to complete construction of the Liquefied Gaseous Fuels Spill Test Facility. This action was concurred in by the House and Senate Appropriations Subcommittees on January 29, 1985.

- A reprogramming within the Atomic Energy Defense Activities appropriation was completed. $3,000,000 was reprogrammed from prior year construction project 82-AD-1, By-Products Uses Demonstration Plants, to By-Products operating expenses in response to the House Committee on Appropriations Report 98-710, which directed the Department to evaluate irradiator operations and to study the application of irradiators to fresh wheat straw and other agricultural products in southwest Oklahoma. This action was concurred in by the House Appropriation Subcommittee on January 25, 1985, and by the Senate Appropriations Subcommittee on February 6, 1985.

- A reprogramming within the Atomic Energy Defense Activities appropriation was completed. $8,000,000 was reprogrammed within the Materials Production program to provide funding for project 83-A-127, Safeguards Improvements, Savannah River. The source of funding for this reprogramming was $3,000,000 from Reactor Operations, $3,000,000 from Processing of Nuclear Materials, $300,000 from Capital Equipment and $3,500,000 from project 81-A-102, Facility Storage Modifications, various locations. This action was concurred in by the House Appropriations Subcommittee on February 11, 1985, and the Senate Appropriations Subcommittee on February 14, 1985.

- A reprogramming of $16,697,000 within the Energy Supply Research and Development Activities appropriation was completed. This action is to accommodate the Small Business Development Act of 1982, Public Law 97-219, which requires the Department of Energy to expend not less than 1 percent of its FY 1985 extramural budget, excluding Atomic Energy Defense Activities, in connection with a Small Business Innovation Research program in FY 1985.

- Appropriation transfers amounting $13,637,000 to the Small Business Innovation Research program were completed. These transfers included $5,165,000 from General Plant Projects and Research Activities, $3,400,000 from Uranium Supply and Enrichment Activities, $3,800,000 from Fossil Energy Research and Development, and $1,272,000 from Energy Conservation. This action is to accordance with the Small Business Development Act of 1982, Public Law 97-219, which requires the Department of Energy to expend not less than 1 percent of its FY 1985 extramural budget, excluding Atomic Energy Defense Activities, in connection with a Small Business Innovation Research program in FY 1985.

- A reprogramming within the Energy Supply Research and Development Activities appropriation was completed. $5,000,000 was reprogrammed from Clinch River Breeder Reactor termination funds to Nuclear Fuel Cycle Research and Development Activities as specified in Congressional reports accompanying the FY 1985 Energy and Water Development appropriation bill.

- A reprogramming within the Energy Supply Research and Development Activities appropriation was completed. $4,000,000 was reprogrammed from unobligated prior year program direction, policy management, and prior year activities which were completed under budget. This action provides funding to initiate activities in FY 1985 to accurately identify and correct environmental problems at San Diego National Laboratory. Concurrence for this action was received from the House Appropriations Subcommittee on February 11, 1985, and the Senate Appropriations Subcommittee on February 25, 1985.

- A reprogramming within the Energy Supply Research and Development Activities appropriation was completed. $500,000 was reprogrammed from operating expenses to capital equipment within the Uranium Mill Tailings Remedial Action (UMTRA) program. The switch between types of funding in the UMTRA program ensures that planned milestones for FY 1985 will be accomplished. This action was concurred in by the House and Senate Appropriations Subcommittees on April 1, 1985.

- A reprogramming within the Departmental Administration appropriation was completed. $4,900,000 was reprogrammed from prior year unobligated balances for classified purposes. This action was concurred in by the House Appropriations Subcommittee on March 4, 1985, and by the Senate Appropriations Subcommittee on April 1, 1985.

- A reprogramming within the Uranium Supply and Enrichment Activities appropriation was completed. $38,000,000 was reprogrammed from prior year unobligated balances. $14,000,000 was for the completion of pre-selection activities and $24,000,000 was to be retained by the Department for orderly program phasedown or continuation once the selection decision was made. This action was concurred in by the House Appropriations Subcommittee on March 22, 1985 and by the Senate Appropriations Subcommittee on March 27, 1985. Letters were sent to the Subcommittees on June 6, 1985 notifying them of the Department's intent to reallocate the $24,000,000 based on the post-selection activities. House and Senate Subcommittees approvals of the June 6, 1985, letters were received on June 26, 1985.

- A reprogramming within the Energy Supply Research and Development Activities appropriation was completed. $1,435,304 was reprogrammed from prior year unobligated balances. This action provides funding for activities in FY 1985 to accurately identify and correct environmental problems at the Oak Ridge National Laboratory. Final Congressional concurrence for this action was received April 3, 1985.

- A reprogramming within the Atomic Energy Defense Activities appropriation was completed. $3,453,000 was reprogrammed to provide funding for the payment of back taxes for the period FY 1979 through FY 1983 to the State of Washington. The requirement to pay back taxes is the result of a recent Supreme Court decision which upheld a Washington State statute imposing a sales tax on Federal contractors with respect to their purchases of materials for Federal projects. $1,720,000 was reprogrammed from project 83-D-157, Additional Radioactive Waste Storage Facilities, Richland; and $1,733,000 from project 81-T-105, Defense Waste Processing Facility, Savannah River. This action was concurred in by the Senate Appropriations Subcommittee on December 21, 1984, and by the House Appropriations Subcommittee on April 10, 1985.

- A reprogramming within the Atomic Energy Defense Activities appropriation was completed. $18,000,000 was reprogrammed from Reactor Operations operating expenses to project 82-D-201, Special Plutonium Recovery Facilities to permit construction of a plutonium storage vault within the Materials Production program. This action was concurred in by the Senate Appropriations Subcommittee on April 1, 1985 and by the House Appropriations Subcommittee on April 19, 1985.

- A reprogramming within the Atomic Energy Defense Activities appropriation was completed. This reprogramming involved a change in project scope to consolidate two construction projects within the Materials Production program. Project 85-D-142, U_3O_8 Fuel Tube Facilities, and Project 85-D-145, Uranyl Nitrate to Oxide Conversion Facility, both at Savannah River, are combined and retitled Project 85-D-145, Fuel Production Facility. This action was concurred in by the Senate Appropriations Subcommittee on April 1, 1985, and by the House Appropriations Subcommittee on April 19, 1985.

- A reprogramming within the Atomic Energy Defense Activities appropriation was completed. $4,863,575 was reprogrammed from unobligated balances associated with various prior year construction projects to operating expenses within the Defense Waste and Byproducts Management program. These funds are being used at Richland, Washington, to prepare the B-Plant facility to handle waste from the PUREX plant rather than place it in standby as previously planned. This action was concurred in by the House Appropriations Subcommittee on April 19, 1985, and by the Senate Appropriations Subcommittee on May 2, 1985.

- An appropriation transfer of $1,081,000 from the Departmental Administration appropriation (Services program, operating expenses) to the Energy Supply Research and Development Activities appropriation (In-House Energy Management program, construction) was completed. This transfer is in consonance with the Committees' agreement to allow the Department to redistribute the reduction for Management Initiatives Savings to those appropriations and programs which actually effected the savings. Concurrence letters were received from the House Appropriations Subcommittee on December 10, 1984, and the Senate Appropriations Subcommittee on December 18, 1984.

- A reprogramming within the Atomic Energy Defense Activities appropriation was completed. $23,000,000 was reprogrammed within the Materials Production program to fund environmental activities at the Savannah River Plant. The source of the funds were $6,300,000 from Reactor Operations, $5,300,000 from processing of Nuclear Materials operating expenses, $10,500,000 from Capital Equipment, and $900,000 from construction project 83-D-147, Pollution Discharge Elimination. This action was concurred in by the Senate Appropriations Subcommittee on March 27, 1985, and by the House Appropriations Subcommittee on April 23, 1985.

- A reprogramming within the Departmental Administration appropriation was completed. The reprogramming reflects the realignment of funding to various organizations due to the FY 1985 pay raise and other staffing adjustments. This action was concurred in by the Senate Appropriations Subcommittee on May 2, 1985, and by the House Appropriations Subcommittee on May 13, 1985.

- The Uranium Supply and Enrichment Activities appropriation reflects the distribution of $10,000,000 from the Advanced Technology Activities Reserve. $5,000,000 was distributed to Gas Centrifuge Operations and Support and $5,000,000 was distributed to Atomic Vapor Laser Isotope Separation. This action is in accordance with pages 101 and 102 of House Report 98-755 dated May 15, 1984.

- A reprogramming within the Atomic Energy Defense Activities appropriation was completed. $2,750,000 was reprogrammed from Weapons Activities Research and Development operating expenses to construction project 85-D-102, Nuclear Weapons Research, Development and Testing Facilities Revitalization, Phase I. This action provides funding for the relocation of shipping and receiving activities at the Sandia National Laboratories, Albuquerque, New Mexico, thereby freeing up urgently needed space to be used for laboratories. Concurrence of this action was received from the House Appropriations Subcommittee on April 19, 1985, and from the Senate Appropriations Subcommittee on June 10, 1985.

- A reprogramming within the Energy Supply Research & Development Activities appropriation was completed. $5,000,000 was reprogrammed from Clinch River Breeder Reactor (CRBR) termination funds to the Loss of Fluid Test (LOFT) Project to complete planned tests in FY 1985. This action was concurred in by the House and Senate Appropriations Subcommittees on June 26, 1985.

- An appropriation transfer of $8,929,000 from Uranium Supply and Enrichment Activities to the Geothermal Resources Development Fund was completed. This action was necessary to replenish the loan guarantee reserve balance to meet financial obligation associated with ending the Government's involvement in the Niland Geothermal project, which was in default status as of July 1, 1985. Authority for this transfer is provided in the General Provisions section 307 of the Energy and Water Development Appropriation Act for FY 1985, Public Law 98-360.

- An appropriation transfer of $6,521,393 from Energy Supply Research and Development Activities to the Nuclear Waste Fund was completed. This transfer results from a determination made by the Main Hurdman auditors that the unobligated balances transferred to the Nuclear Waste Fund as of January 7, 1983, should have included an additional $6,521,393 to cover contracts specifically identified with the Nuclear Waste Fund. This transfer is in accordance with the Nuclear Waste Policy Act of 1982, Public Law 97-425 (96 STAT 2259), signed January 7, 1983.

- A reprogramming within the Energy Supply Research and Development Activities appropriation was completed. $1,580,000 was reprogrammed within the Nuclear Energy program to provide funding for support of the North Warning System. This action was concurred in by the House Appropriations Subcommittee on June 26, 1985, and by the Senate Appropriations Subcommittee on July 15, 1985.

FY 1986

- A reprogramming within the Energy Supply, Research and Development Activities appropriation was completed. $2,500,000 was reprogrammed from construction project 84-CE-01, Sacramento Municipal Utility Development, to Mod 5 Wind Turbine operating expenses as directed by the FY 1985 Supplemental Appropriations Bill. This action was concurred in by the House and Senate Appropriations Subcommittees on October 8, 1985.

- A reprogramming within the Energy Supply, Research and Development Activities appropriation was completed. $363,000 was reprogrammed from Reactor Core Technology Test Facilities to the Advanced Light Water Reactor to provide support funding for the North Warning System. Final Congressional concurrence for this action was received October 28, 1985.

- An appropriation transfer of $15,000,000 from Uranium Supply and Enrichment Activities to the Geothermal Resources Development Fund was completed. The funds transferred will replenish the loan guarantee reserve balance in the Geothermal Resources Development Fund to meet imminent financial obligations associated with the Government's involvement in the Westmoreland project and any possible future defaults. Authority for this transfer is provided by Public Law 99-88, the FY 1985 Supplemental Appropriation Act.

- A reprogramming within the Atomic Energy Defense Activities appropriation was completed. The amount of $8,200,000 was reprogrammed from the Waste Isolation Pilot Plant (WIPP) construction project 77-13-f to capital equipment within the Defense Waste and Byproducts Management program. These funds are being used to initiate the procurement of transportation containers to permit transuranic (TRU) radioactive waste to be shipped to the WIPP facility when it opens in late 1988. This action was concurred in by the Senate Appropriations Subcommittee on January 21, 1986, and by the House Appropriations Subcommittee on January 28, 1986.

- An appropriation transfer of $976,943 to the Energy Supply Research and Development Activities appropriation was completed. This transfer is in consonance with the Committees' agreement to allow the Department to redistribute the reduction for Management Initiative Savings to those appropriations and programs which actually effected the savings. Funds were transferred from the following appropriations:

General Science and Research Activities	$ 108,572
Uranium Supply and Enrichment Activities	331,022
Southeastern Power Administration	8,965
Southwestern Power Administration	528,384
Total Funds Transferred	$ 976,943

Concurrence letters were received from the House Appropriations Subcommittee on December 10, 1984, and the Senate Appropriations Subcommittee on December 18, 1984.

- A reprogramming of $16,239,000 within the Energy Supply Research and Development Activities appropriation was completed. This action is in accordance with the Small Business Development Act of 1982, Public Law 97-219, which requires the Department of Energy to expend not less than 1.25 percent of its FY 1986 extramural budget, excluding Atomic Energy Defense Activities, in connection with a Small Business Innovation Research program in FY 1986.

Reprogrammings

Mr. Bevill. Are you aware of a need for additional reprogrammings in FY 1986?

Secretary Herrington. The Department does anticipate a need for additional reprogramming actions this year. Specifically, reprogramming actions will be required in several accounts in the Energy and Water Development Appropriation to appropriately distribute general reductions. Also, reprogramming actions will be necessary in the Energy Supply Research and Development account to offset FY 1986 and FY 1987 funding shortfalls in the Technical Information Management Program; and in the Departmental Administration account to support staffing levels and fixed operational costs. In the event that unforeseen circumstances, conditions, or budget reductions necessitate changes in program execution, additional reprogramming actions may be forthcoming.

DEFERRALS

Mr. Bevill. Provide for the record a summary description of each item that is proposed to be deferred, the reasons for the deferral, the programmatic impact of each and indicate which of the deferrals were proposed in items added by a Congressional committee.

Secretary Herrington. I would be happy to provide that information for the record. (The information follows:)

Department of Energy
FY 1986 Deferrals

(Dollars In Thousands)

Appropriation	Deferred	Add-On	Impact	Reason
Energy Supply R&D				
Renewables				
o Solar Energy				The deferrals in the Renewables area were made, in most instances, consistent with the President's FY 1987 policy to reduce Federal expenditures particularly for program areas in which a Federal role is questionable, and for which appropriations were not being requested in FY 1987. In general, demonstration projects, outreach and information type efforts and funding which exceeded optional levels in R&D efforts were deferred.
-Photovoltaics	$ 4,019	$ 4,019		
SW residential experiment began reductions in Mid-February, but is retaining a core staff thru March.	(1,914)	(1,914)	Deferral of funding for operation of the residential experimental stations at Austin, Texas.	
New contractual effort.	(957)	(957)	Deferral of funding for the Massachusetts Photovoltaic Center.	
Add-on to existing program.	(1,148)	(1,148)	Deferral of funding for other photovoltaic R&D not specifically identified in Committee Report language but added above the President's Request.	
-Wind MOD-5 Wind Machine	10,240	10,240	Termination of further programmatic efforts.	
-Ocean Add-on for continuation of on-going program.	1,436	1,436	Deferral of funding for two 50kW apparatus tests under the PICHTR open-cycle projects.	
-Solar International Continuation of on-going program.	762	957	Deferral of funding for support to DOC for promotion of U.S. solar products for export purposes.	
-Solar Program Support Continuation of on-going program.	195	---	Deferral of funding needed for contractual support.	
Subtotal, Solar Energy	$16,652	$16,652		

Department of Energy
FY 1986 Deferrals

(Dollars In Thousands)

Appropriation	Deferred	Add-On	Impact	Reason
o Electric Energy Systems Add-on for continuation of on-going program.	1,914	1,914	Deferral of funding for systems technology to advance the state-of-the-art in electric system concept and technologies.	
o Energy Storage Systems Add-on for continuation of on-going program.	1,914	1,914	Deferral of funding for zinc/bromine battery work.	
o Geothermal	$ 2,871	$ 2,871		
-Hydrothermal Industrialization New activity - no funds to be expended.	(1,914)	(1,914)	Deferral of funding to assist States with significant hydrothermal resources to continue programs to exploit this resource.	
-Geopressured Resources Continuation of on-going program.	(957)	(957)	Deferral of funding for continued analysis of long-duration flow test data from design wells.	
o Technical Information Management Program (TIMP) Continuation of on-going program into FY 1987 (not an add-on) reprogrammed form In-House.	$ 3,923	$ ---	Deferral of funds from FY 1986 to offset on-going requirements in FY 1987. These funds are reprogrammed from the In-House Energy Management Program in FY 1986. Reprogramming request will accompany the FY 1987 budget to Congress.	Funds are required to to continue TIMP at the on-going level of activity.

Department of Energy
FY 1986 Deferrals

(Dollars In Thousands)

Appropriation	Deferred	Add-On	Impact	Reason
Departmental Administration				
-Office of Minority Economic Impact Continuation of on-going program in FY 1987, add-on funding in FY 1986 stretches out.	$393	$957	Deferral of funds into FY 1987 will allow continuation of programs initiated in FY 1986. The program pace will be constant in FY 1986 and FY 1987.	Reducing Federal expenditures in FY 1986 and maintaining a program pace at a level which the program can operate effectively.

Department of Energy
FY 1986 Deferrals

(Dollars In Thousands)

Appropriation	Deferred	Add-On	Impact	Reason
Alaska Power Administraton				
FY 1985 Unobligated Balances (Not applicable to FY 1986 project terminations.)	$ 400	$---	Deferral of FY 1985 unobligated balances. There is no significant programmatic effect of withdrawal of these funds from FY 1986.	The need to reduce Federal expenditures in FY 1987 out weighs any advantage which may be gained from obligating these funds in FY 1986.
Total, Alaska Power Administration	$ 400	$---		

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Department of Energy
FY 1986 Deferrals

(Dollars In Thousands)

Appropriation	Deferred	Add-On	Impact	Reason
Southwestern Power Administraton				
FY 1985 Unobligated Balances (Not applicable to FY 1986 project terminations.)	$13,243	$ ---	Deferral FY 1985 unobligated balances. There is no significant programmatic effect of withdrawal of these funds from FY 1986.	The need to reduce Federal expenditures in FY 1987 out weighs any advantage which may be gained from obligating these funds in FY 1986.
Total, Southwestern Power Administration	$13,243	$ ---		

Department of Energy
FY 1986 Deferrals

(Dollars In Thousands)

Appropriation	Deferred	Add-On	Impact	Reason
Southeastern Power Administraton				
FY 1985 Unobligated Balances (Not applicable to FY 1986 project terminations.)	$2,089	$ ---	Deferral of FY 1985 unobligated balances. There is no significant programmatic effect of withdrawal of these funds from FY 1986.	The need to reduce Federal expenditures in FY 1987 out weighs any advantage which may be gained from obligating these funds in FY 1986.
Total, Southeastern Power Administration	$2,089	$ ---		

Department of Energy
FY 1986 Deferrals

(Dollars in Thousands)

Appropriation	Deferred	Add-On	Impact	Reason
Western Area Power Administration				
FY 1985 Unobligated Balances (Not applicable to FY 1986 project terminations.)	$43,466	$ ---	Deferral of FY 1985 unobligated balances. There is no significant programmatic effect of withdrawal of these funds from FY 1986.	The need to reduce Federal expenditures in FY 1987 out weighs any adeantage which may be gained from obligating these funds in FY 1986.
Total, Western Area Power Administration	$43,466	$ ---		

[illegible]

(Dollars in Thousands)

Appropriation	Deferred	Add-On	Impact	Reason
Uranium Enrichment Activities:				
Diffusion Operation	$ (49,40)	—	Savings as a result of current and prior year power cost savings and from putting GDUP in standby in FY 1998.	Funds are excess to the production requirements.
Gas Centrifuge Enrichment Plant	616,717	—	FY 1998 Appropriation of $207,457,000 and prior year deobligations of $107,760,000 resulting from termination of GCEP.	Project has been terminated as not cost effective or required for the transmutation core production requirements.
Total	$ 568,760			

DEFERRALS

Mr. Boyll. For each proposed deferral, discuss the impact of it and identify how much funding has been invested to date, by project.

Secretary Harrington. I would like to insert in the record a table depicting the deferral information as requested.

(The information follows:)

Deferrals
(Dollars in Thousands)

	Deferral	Total Investment to date	Impact
Energy Supply R&D			
Solar			
Photovoltaics			
Austin, Texas	$ 957	$ -0-	Project not yet begun.
Massachusetts P.V. Center	957	-0-	Project not yet begun.
Residential Experiment Station	861	4,600	Shut down in late March.
Other R&D	287	N/A	Reduced level of R&D.
Wind			
MOD-5 Wind turbine	10,241	50,400	Federal involvement would cease in FY 1986 and continuation of the project would be left to the private sector.
Ocean			
Open cycle (PICHTR)	478	-0-	Project not yet begun.
Open cycle testing in Hawaii & Florida	957	-0-	Project not yet begun.
Solar International	762	N/A	Reduced promotion of U.S. Solar products for export.
Program Support	195	N/A	Reduced solar crosscutting analytical studies.
Electric Energy Systems			
Systems Technology	1,914	N/A	Projects not yet begun.
Energy Storage Systems			
Battery R&D	1,914	N/A	New projects on advanced battery R&D have not yet begun.

Deferrals
(Dollars in Thousands)

	Deferral	Total Ivestement to date	Impact
Geothermal			
Hydrothermal Industrialization	$ 1,914	N/A	Projects not yet begun.
Geopressured Resources	957	N/A	On-going projects would be slowed and stretched out in FY 1986.
Technical Information Management Program	3,392	N/A	Funds from In-House Energy Management projects which experienced underruns and which are no longer competitive are available for deferral. The funds will be used to maintain the Technical Information Management Program at the $15 million level in FY 1987.
Alaska PMA	400	N/A	No significant impact. Source of funding is FY 1985 unobligated balances.
Southwestern PMA	13,243	N/A	No significant impact. Source of funding is FY 1985 unobligated balances.
Southeastern PMA	2,089	N/A	No significant impact. Source of funding is FY 1985 unobligated balances.
Western PMA	43,466	N/A	No significant impact. Source of funding is FY 1985 unobligated balances.
Departmental Administration			
Office of Minority Economic Impact	393	N/A	The Minority Educational Institution Assistance Program will continue into FY 1987 - program will be conducted at a slower pace in FY 1986.

Deferrals
(Dollars in Thousands)

	Deferral	Total Investment to Date	Impact
Uranium Enrichment			
Gas Centrifuge Project	434,757	2,588,000	Results from the termination of GCEP.
Oak Ridge Diffusion Operation	149,401	N/A	No impact. The deferral is a result of current and prior year power cost savings and from putting Oak Ridge Gaseous Diffusion Plant in standby in FY 1986.

DEFERRALS

Mr. Bevill. For each deferral, describe why funds were proposed to be deferred instead of proposed for rescission.

Secretary Herrington. We have proposed deferrals rather than rescissions because under the Budget Control and Impoundment Act of 1974 a deferral is appropriate when the President proposes a delay in obligating funds appropriated by the Congress. Our proposal is not to eliminate these funds, but rather to delay obligating them until FY 1987, which will offset new budget authority requirements in that year. Our FY 1987 budget proposal reflects this plan. I believe that this approach is consistent with recent Comptroller General opinions on the proper treatment of rescissions and deferrals.

PERSONNEL LEVELS

Mr. Bevill. Provide for the record a table showing the FY 1985, 1986, and 1987 proposed personnel levels for each organizational entity in the Department.

Secretary Herrington. I would like to provide for the record the proposed personnel levels for the Department for FY 1985, 1986, and 1987.

(The information follows:)

DOE STAFFING DISTRIBUTION FY 1987 BUDGET

ORGANIZATIONS	FY 1985 ACTUAL	FY 1986 ALLOWANCE	FY 1987 REQUEST	DIFF FY86 TO FY87
DEFENSE PROGRAMS	2424	2489	2620	131
ENERGY RESEARCH	359	358	358	0
NUCLEAR ENERGY	477	459	446	-13
FOSSIL ENERGY *	996	956	756	-200
CIV RADIOACTIVE WASTE MGT	224	277	275	-2
CONS & RENEWABLE ENERGY	457	483	327	-156
ENVIR, SAFETY & HEALTH **	104	128	130	2
TOTAL PROGRAM ORGS	5041	5150	4912	-238
ALASKA	37	38	38	0
BONNEVILLE	3510	3480	3480	0
SOUTHEASTERN	38	40	40	0
SOUTHWESTERN	186	186	186	0
WESTERN AREA	1400	1379	1379	0
TOTAL PWR MKTG ADMINS	5171	5123	5123	0
ECON REGULATORY ADMIN	295	250	206	-44
HEARINGS & APPEALS	82	90	84	-6
ENERGY INFORMATION ADMIN **	484	485	479	-6
TOTAL REGULATION & INFO	861	825	769	-56
OFFICE OF THE SECRETARY	36	31	31	0
POLICY, PLANNING & ANALYSIS	61	64	64	0
INTL AFFAIRS & ENERGY EMERG	136	134	134	0
GENERAL COUNSEL **	190	170	170	0
INSPECTOR GENERAL	179	178	178	0
CONG, INTERGOVT & PUB AFF **	93	90	90	0
BOARD OF CONTRACT APPEALS	7	8	8	0
MINORITY ECON IMPACT	11	11	11	0
MANAGEMENT & ADMINISTRATION **	1092	1124	1124	0
OFC SCIENTIFIC & TECH INFO	175	175	175	0
TOTAL POLICY & SUPPORT	1980	1985	1985	0
MULTI PURPOSE OPS OFFICES	1588	1608	1603	-5
Subtotal DOE	14641	14691	14392	-299
FEDERAL ENERGY REG COMM	1617	1659	1659	0
TOTAL	16258	16350	16051	-299
MANAGEMENT INITIATIVES		-132	-330	-198
OMB ALLOWANCE *		16218	15721	-497
* Excludes OFI staffing for FY 1986 and FY 1987		(10)	(3)	

** INCLUDES FTES FOR NUCLEAR WASTE FUND ACTIVITIES

GRACE COMMISSION RECOMMENDATIONS

Mr. Bevill. The Grace Commission issued several reports a number of years ago on agency management and operations. Could you tell the Committee what action you have taken to address the recommendations of the Grace Commission and what the results have been?

Secretary Herrington. A large number of Grace Commission recommendations have been implemented in FY 1986 and prior budgets. Examples include: reducing the level of "micromanagement" of our GOCO facilities, improvements in organization and staffing, increased utilization of commercial printing facilities, improvements to our financial systems, A-76/Productivity savings, improved ADP utilization, and additional recoveries through increased Inspector General audits.

The FY 1987 budget proposes both Rate Reform and the sale of the Power Marketing Administrations.

The Department has saved over $180 million between FY 1984 and 1986, exclusive of the savings from reducing the fill-rate of the SPR. The reduced SPR fill-rate resulted in estimated cost avoidance of $3.5 billion between FY 1984 and FY 1986.

The FY 1987 budget request included the sale of the PMAs and reflects deficit reductions (net revenues) of $12.6 billion between FY 1987 and FY 1991. This projected savings is based on unpaid federal investment. The Grace Commission estimated savings of $25 billion based on several factors such as market value, replacement costs and appropriated costs.

Actions taken to date as well as proposed actions in the FY 1987 budget request, demonstrate that DOE has implemented or proposed all substantive recommendations of the Grace Commission effecting DOE and its programs.

GRAMM-RUDMAN-HOLLINGS SEQUESTRATIONS

Mr. Bevill. Provide a summary table of the Gramm-Rudman-Hollings sequestrations, by appropriation account, and a copy of agency guidance with regard to how reductions were to be made.

Secretary Herrington. Mr. Chairman, I will provide that information for the record.

(the information follows:)

GRAMM-RUDMAN-HOLLINGS REDUCTIONS - FY 1986
(Public Law 99-177)

Account Title	FY 1986 G-R-H Reduction
ENERGY AND WATER DEVELOPMENT ACCOUNTS:	
Energy Supply Research and Development	-76,208
Uranium Enrichment Activities	-61,391
General Science and Research	-29,472
Atomic Energy Defense Activities	-372,626
Departmental Administration	-16,106
Power Marketing:	
Alaska Power Administration	-36
Southwestern Power Administration	-309
Western Area Power Administration	-1,590
Total, Power Marketing	-1,935
Federal Energy Regulatory Commission	-4,109
Nuclear Waste Disposal Fund	-22,423
Geothermal Resources Development Fund	-3
Total, Energy and Water Development Accounts	-584,273
INTERIOR ACCOUNTS:	
Fossil Energy Research and Development	-14,017
Naval Petroleum and Oil Shale Reserves	-584
Energy Conservation	-19,209
Economic Regulation	-1,052
Emergency Preparedness	-258
Strategic Petroleum Reserve	-4,832
Energy Information Administration	-2,594
TOTAL, INTERIOR ACCOUNTS	-42,546
TOTAL, DEPARTMENT OF ENERGY	-626,819

Department of Energy

Balanced Budget and Emergency Deficit Control Act of 1985
Public Law 99-177 (Gramm-Rudman-Hollings Act)

o In essence these instructions are intended to:

-- provide background information and reference materials to understand requirements being imposed;

-- provide an explanation of our FY 1986 budget execution procedures for reductions; and

-- explain program responsibility for applying further specific reductions.

o The following material is attached:

1. Summary of Deficit Control Act Provisions - This Congressional report summarizes the major provisions of the deficit reduction act. Also attached is an excerpt from the Congressional Record that defines "Program, Project and Activity" and includes specific guidance from the Energy and Water and Interior appropriations subcommittees.

2. OMB Bulletin 86-5 entitled, "Initial Reporting Requirements of the Balanced Budget and Emergency Deficit Control Act".

3. OMB Memorandum entitled, "Obligation of Funds in FY 1986 and Effects of Changes in Technical Factors for FY 1987".

o A table showing DOE's initial allocation of reductions to the Base Table control level will be provided as soon as available. In certain cases, Programs will have to proportionately apply specific reductions below the Base Table level.

o Implementation and execution of imposed FY 1986 deficit reductions will follow procedures outlined below:

1. The Office of Budget will direct and coordinate required deficit reduction activities for the Department. This includes making approved funding plan (AFP) reductions and preparing financial reports required by OMB and Congress.

2. Program organizations are responsible for proportionally applying actual reductions to programs, projects and activities and initiating AFP and other necessary changes to maintain Base Table control. In addition, organizations need to review their FY 1986 appropriation acts and related committee and conference reports to identify any specific program, project or activities referenced that are funded below the Base Table control level. For each such item, Program Organizations are to proportionately reduce FY 1986 funding for each of these items. Program organizations may be required at a later date to submit a further detailed listing of specific areas where the reductions were made.

3. For non-Defense programs, the amount of reductions will be applied proportionally to the new budget authority for each Base Table ine item control. For Defense Programs, the amount of reductions will be applied proportionately to the total obligational authority (unobligated carryover into FY 1986 plus new budget authority) for each Base Table line item control.

4. The Headquarters program organizations will be required to submit certified approved funding program (AFP) input data identifying the individual AFP line items to be reduced. (The certification states that the funds are unobligated and available for withdrawal).

5. Additional instructions to the program organizations concerning the application of these reductions should be as follows:

   a) That the reductions must be applied proportionately within the Base Table line item. When distributing reductions, program organizations must be mindful of the Subcommittee guidance concerning definition of "Program, Project or Activity" shown in the attached excerpts from the Congressional Record.

   b) For Defense programs, certain programs, projects, or activities could be reduced by an amount up to two times the uniform reduction, and other programs, projects and activities within the same account could be spared from some or all of the cut. No projects, programs, or activities could be increased above base levels. In applying this flexibility, no reductions can be made from items of congressional interest by more than the uniform percentage that is to be applied to the account as a whole. "Congressional interest" items are those projects, programs and activities that have been appropriated in the final defense appropriation conference report for FY 1986 at a level 110 percent higher than the President's request.

   c) Organizations encountering problems in complying with the above guidance on distribution of these reductions should address questions to your respective budget analyst in the Office of Budget

EMPLOYMENT LEVELS

Mr. Bevill. Provide a summary table showing employment levels for the agency in the same format that appears in House Report 99-195 on page 8.

Secretary Herrington. The employment levels will be provided for the record in the requested format.

(The information follows:)

DOE EMPLOYEES FUNDED BY ENERGY AND WATER DEVELOPMENT APPROPRIATIONS

FY 1985			FY 1986			FY 1987		
FEDERAL	NON-FEDERAL	TOTAL	FEDERAL	NON-FEDERAL	TOTAL	FEDERAL	NON-FEDERAL	TOTAL
13998	130528 *	144526	14156	126294 *	140250	14243	124000 *	138243

* TOTAL NUMBER OF EMPLOYEES IN GOVERNMENT OWNED, CONTRACTOR OPERATED (GOCO) FACILITIES, SOME OF WHICH ARE FUNDED BY INTERIOR AND RELATED AGENCIES APPROPRIATIONS. FY 1985 REPRESENTS ACTUAL EMPLOYMENT. FY 1986 AND FY 1987 ESTIMATED EMPLOYMENT LEVELS REFLECT ESTIMATED IMPACTS OF FY 1986 GRAMM-RUDMAN-HOLLINGS ACT FUNDING REDUCTIONS.

APPROPRIATION SUMMARY

Mr. Bevill. Provide a summary table showing the breakdown of appropriations by capital and operating expenses in the same format that appears in House Report 99-195 on page 7.

Secretary Herrington. Mr. Chairman, I will be happy to provide that for the record.

(the information follows:)

[redacted]

Account Title	FY 2007 [redacted]
[redacted]	
[redacted]	
[redacted]	

[illegible]

Mr. Quirk. Provide a summary table showing the price that each architect worked and actual outlays, by appropriation account and a table showing the 1987 budget authority request and outlays associated with that request for the same five years. Provide that by appropriation account.

Secretary Herrington. Mr. Chairman, I will be happy to provide those tables for the record.

[The information follows:]

DEPARTMENT OF ENERGY
FY 2007 CONGRESSIONAL BUDGET
(DOLLARS IN THOUSANDS)

BUDGET AUTHORITY

Account Title		FY 2004 Prior Year	FY 2005 Request	FY 2005 Prior Year	FY 2005 Request	FY 2005 Prior Year
Summary By Appropriation:						
Energy supply and conservation		1,201,347	1,287,251	1,241,000	1,224,261	1,241,000
Uranium enrichment		-1,000	2,000	10,000	10,277	-5,000
General counsel		67,000	69,000	67,000	79,736	67,267
Atomic energy		6,858,000	6,219,747	7,220,000	7,080,000	7,132,150
Departmental administration		99,000	94,000	99,000	90,000	90,000
Power Marketing Administrations:						
Alaska Power Administration		3,000	3,000	3,000	3,000	3,000
Bonneville Power Administration		-149,000	-140,000	-140,000	-140,000	-83,700
Southeastern Power Adm.		6,000	6,746	6,000	6,000	6,000
Southeastern Adm. Fund		---	---	---	---	---
Southwestern Power Adm.		31,775	31,917	29,000	29,000	29,000
Southwestern Power Adm. Fund		---	---	---	---	---
Western Area Power Adm.		349,000	339,000	339,000	399,000	399,000
Offsetting Fund		---	---	---	---	---
Colorado River Basin		-33,000	-31,000	0	-29,000	-29,000
Total, Power Marketing Administrations		8,000	-45,000	-73,000	-30,000	320,000
FERC Salaries and Expenses		29,000	30,000	30,000	31,000	30,000
Nuclear Waste Fund		983,000	377,000	611,000	833,000	983,000
Nonproliferation		1,000	1,000	8,000	10,000	11,000
Uranium Enrichment Decontamination and Decommissioning Fund		---	---	1	0	---
Alternative Fuels Production		1,000	1,000	1,000,000	1,000,000	11,000
Clean Coal Technology		---	---	---	---	1,000
Fossil Energy		435,000	444,000	439,000	437,000	460,000
Naval Petroleum and Oil Shale Reserves		20,000	20,000	20,000	111,000	111,000
Energy Conservation		838,000	833,000	802,000	844,000	838,000
Energy Reporting		31,000	31,000	31,000	31,000	31,000
Emergency Preparedness		---	---	5,000	4,000	4,000
Strategic Petroleum Reserve		1,000,000	1,017,000	1,004,000	1,010,000	211,000
Energy Information Activities		85,000	85,000	85,000	84,000	85,000
Payments to States		300	300	375	375	375
Subtotal, Energy		12,000,000	11,000,000	11,000,000	11,000,000	12,000,000
Proposed Legislation - Privatization of SPR		---	---	---	---	---
Total, Energy		12,000,000	11,000,000	11,000,000	11,000,000	12,000,000

DEPARTMENT OF ENERGY
FY 1987 CONTROL TABLE
(DOLLARS IN THOUSANDS)

OUTLAYS
BY APPROPRIATION

Account Title	FY 1984 Plan B/O	FY 1984 Actual B/O	FY 1985 Plan B/O	FY 1985 Actual B/O	FY 1986 Plan B/O
Receipts - Outlays					
Naval Petroleum Reserve - B/O	-1,592,656	-1,580,392	-848,888	-846,038	-831,152
Power Marketing Administration - B/O	-488,074	-444,576	-610,229	-622,297	-682,227
Waste Disposal Fund - B/O	-322,300	-329,539	-1,785,277	-1,794,756	-380,900
NWF - Interest Realized - B/O	---	---	---	73,745	-118,000
Other - B/O	-2,000	---	-8,200	---	-10,500
Total Receipts - Outlays	-2,405,030	-2,354,507	-3,252,594	-3,189,346	-2,022,779
Total DOE Outlays Less Receipts	10,533,900	10,692,572	11,810,793	11,908,495	10,085,441

			AUTHORITY		
ACCOUNT TITLE	FY 1987 OBL. EST. $K	FY 1988 OBL. EST. $K	FY 1989 OBL. EST. $K	FY 1990 OBL. EST. $K	FY 1991 OBL. EST. $K
CHANGE IN UNOBLIGATED					
[illegible]	1,334,342	1,607,329	1,237,347	1,319,446	1,337,877
[illegible]	----	----	----	----	----
[illegible]	772,000	838,000	891,900	915,000	1,488,000
[illegible]	8,370,000	8,720,000	9,330,000	9,630,000	9,930,000
[illegible]	72,442	80,699	72,000	72,787	72,914
FOOD SERVICE ADMINISTERED					
[illegible]	3,000	3,747	3,437	3,483	3,530
[illegible]	276,103	328,760	291,900	279,000	284,000
[illegible]	37,647	37,628	45,623	46,097	47,779
[illegible]	----	----	----	----	----
[illegible]	35,227	46,172	41,407	43,872	44,000
[illegible]	----	----	----	----	----
[illegible]	300,300	307,000	320,000	414,000	400,000
[illegible]	----	----	----	----	----
[illegible]	----	----	----	----	----
[illegible]	564,291	765,848	722,366	806,840	782,173
[illegible]	26,225	5,740	4,201	3,290	3,565
[illegible]	760,249	843,664	799,202	723,771	681,720
[illegible]	72	72	72	72	72
[illegible]	----	----	----	----	----
[illegible]	----	----	----	----	----
[illegible]	----	----	----	----	----
[illegible]	83,767	138,694	161,869	167,373	173,564
[illegible]	137,900	177,780	151,350	147,300	143,740
[illegible]	79,472	72,664	78,000	78,445	82,677
[illegible]	21,850	13,000	5,000	4,000	4,000
[illegible]	4,000	4,000	4,000	4,000	4,000
[illegible]	----	102,975	168,425	166,754	170,963
[illegible]	59,621	63,697	64,332	64,320	65,580
[illegible]	570	570	570	570	570
[illegible]	----	----	----	----	----
[illegible]	13,366,667	13,716,481	14,395,731	14,866,139	15,371,467
[illegible]	-34,305	----	----	----	----
[illegible]	13,021,362	13,716,481	14,395,731	14,866,139	15,371,467

ACCOUNT TITLE	DEPARTMENT OF ENERGY FY 1987 CONGRESSIONAL BUDGET (BUDGET AUTHORITY IN THOUSANDS)	OUTLAYS BY APPROPRIATION			
	FY 1987 CONG. REQ. BUD	FY 1988 CONG. REQ. BUD	FY 1989 CONG. REQ. BUD	FY 1990 CONG. REQ. BUD	FY 1991 CONG. REQ. BUD
SUMMARY BY APPROPRIATION (D/O)					
ENERGY SUPPLY PROGRAMS (D/O)	1,809,679	1,817,942	1,888,159	1,937,469	1,940,913
[illegible] (D/O)	-235,000	-270,000	-270,000	-270,000	-270,000
[illegible] (D/O)	736,539	787,000	891,000	927,000	1,463,000
[illegible] (D/O)	7,788,887	8,000,000	9,000,000	9,370,000	9,760,000
[illegible] (D/O)	143,593	140,380	140,500	151,361	130,600
POWER MARKETING ADMINISTRATIONS (D/O)					
ALASKA POWER ADMINISTRATION (D/O)	3,276	3,201	3,201	3,201	3,201
BONNEVILLE POWER ADMINISTRATION (D/O)	-177,397	-30,300	-126,700	-176,000	-189,700
SOUTHEASTERN POWER (D/O)	21,162	27,139	44,086	59,705	61,640
SOUTHEASTERN (FUT. FUND) (D/O)	-----	-----	-----	-----	-----
SOUTHWESTERN POWER (D/O)	38,503	40,123	41,667	43,072	44,485
SOUTHWESTERN POWER (FUT. FUND) (D/O)	-----	-----	-----	-----	-----
WESTERN AREA POWER (D/O)	281,709	280,700	321,460	430,700	390,100
UMPA (REPAYMENT) (D/O)	-----	-----	-----	-----	-----
COLORADO RIVER (D/O)	-44,044	-76,700	-81,300	-59,300	-59,000
TOTAL, POWER MARKETING ADMINISTRATIONS (D/O)	122,649	240,234	302,374	281,389	368,844
FOSSIL SALARIES AND EXPENSES (D/O)	10,355	5,484	2,665	2,665	500
NUCLEAR WASTE FUND (D/O)	240,834	888,144	814,042	736,174	667,430
GEOTHERMAL RESOURCES (D/O)	000	000	000	000	000
SPECIAL FOREIGN CURRENCY (D/O)	-----	-----	-----	-----	-----
ALTERNATIVE FUELS PRODUCTION (D/O)	-----	-----	-----	-----	-----
CLEAN COAL TECHNOLOGY (D/O)	94,438	125,150	149,000	24,855	-----
FOSSIL ENERGY (D/O)	140,884	140,000	170,000	170,000	170,000
NAVAL PETROLEUM AND OIL SHALE RESERVES (D/O)	146,137	172,850	174,150	188,300	191,500
ENERGY CONSERVATION (D/O)	238,962	215,000	130,000	80,000	80,000
ENERGY REGULATION (D/O)	21,461	13,000	5,000	6,000	6,000
EMERGENCY PREPAREDNESS (D/O)	5,967	6,000	6,000	6,000	6,000
STRATEGIC PETROLEUM RESERVE (D/O)	230,420	230,936	159,579	165,015	170,223
ENERGY INFORMATION ACTIVITIES (D/O)	58,362	61,402	63,414	65,644	67,756
PAYMENTS TO STATES (D/O)	570	570	570	570	570
GENERAL DOE OUTLAYS (D/O)	12,402,230	12,999,002	13,368,046	13,886,574	14,322,444
PROPOSED LEGISLATION - PRIVATIZATION OF SPR (D/O)	-30,130	-----	-----	-----	-----
TOTAL, DOE OUTLAYS (D/O)	11,972,000	12,999,002	13,368,046	13,886,574	14,322,444

DEPARTMENT OF ENERGY
FY 1987 CONTROL TABLE
(DOLLARS IN THOUSANDS)

BA/BO
BY APPROPRIATION

ACCOUNT TITLE	FY 1987 CONG. REQ. B/A	FY 1988 CONG. REQ. B/A	FY 1989 CONG. REQ. B/A	FY 1990 CONG. REQ. B/A	FY 1991 CONG. REQ. B/A
RECEIPTS					
NAVAL PETROLEUM RESERVE	-1,011,809	-924,993	-858,735	-812,178	-780,857
POWER MARKETING ADMINISTRATION	-690,182	-702,489	-721,438	-743,630	-784,730
WASTE DISPOSAL FUND	-423,000	-491,700	-526,100	-547,425	-570,240
NRF - INTEREST REALIZED	-115,000	-105,000	-99,000	-96,000	-105,000
OTHER	-6,600	-6,600	-6,600	-6,600	-6,600
TOTAL RECEIPTS	-2,246,591	-2,230,782	-2,211,893	-2,205,833	-2,247,427
TOTAL DOE LESS RECEIPTS = B/A	9,774,711	11,485,619	12,183,858	12,634,291	13,124,240
TOTAL DOE OUTLAYS LESS RECEIPTS = B/O	9,726,489	10,769,060	11,296,953	11,600,743	12,075,239

URANIUM ENRICHMENT

Mr. Bevill. Mr. Secretary, the FY 1987 uranium enrichment budget assumes sales of inventory, the payment of $454 million in demand charges and repayment of $235 million. This amounts to 53% of the budget authority request for entirely "non-productive" purposes. How is the United States to maintain a viable uranium enrichment enterprise when so much of the program now and in the future is committed to non-productive efforts?

Mr. Herrington. The payment of $454 million in capacity charges for electricity not utilized by the Department is planned to be made under the contractual terms of the power supply contract between DOE and the Tennessee Valley Authority. DOE has made numerous attempts over the past several years to obtain relief from these payments but, to date, TVA has been unresponsive to these requests. Unless and until the Department can find some means to obtain reductions in these payments, appropriations for these fixed costs are necessary. DOE is able to met its production requirements in FY 1987 by selling about 4 million separative work units of enriched uranium from its inventory.

By drawing down DOE's enriched uranium inventory and reducing costs for AVLIS and the gaseous diffusion complex, DOE will generate $235 million in cash, which is proposed for payment to the Treasury in FY 1987. Concurrently, DOE prices for enrichment services will be reduced by $6 to $119 per separative work unit in FY 1987, a level consistent with DOE's commitment to regain and maintain a competitive pricing posture. The overall FY 1987 enrichment budget proposal reflects a balance between the need to maintain a competitive enrichment enterprise and the desire to reduce the Federal budget deficit.

Mr. Bevill. The budget request indicates that the AVLIS technology will be "privatized" in the future. What does that mean and what specific proposals or requests does the Department have from the private sector to do this?

Mr. Herrington. DOE is in the process of evaluating how best to involve the private sector in the development and ultimate deployment of AVLIS technology. A draft request for expressions of interest is under review. Its purpose will be to identify potential industrial and financial participants and the terms and conditions they would require in order to undertake AVLIS R&D and commercialization. At this time, the Department has not requested or received any proposals or formal requests concerning industrial or financial involvement in AVLIS.

Mr. Bevill. Since the decision was made to select AVLIS as the technology of choice for future uranium enrichment, what changes have been made in the development program? What specific changes in planned schedules, estimated development and deployment costs and other program elements have occurred?

Mr. Herrington. Immediately following the AVLIS selection, the Department and AVLIS process developers conducted a comprehensive planning effort to develop an AVLIS strategy within the context of the enrichment enterprise, assuming Government ownership. Under the strategy that evolved, AVLIS would be deployed when its production costs could be confidently projected to fall below Gaseous Diffusion Plant production costs and market conditions and available resources permit such an undertaking. Reflected in the Department's FY 1987 budget request to Congress is an initiative to transfer responsibility for further development of the AVLIS technology to the private sector. As a result, AVLIS program planning is being modified to encourage private sector participation.

AVLIS program goals for the FY 1987 budget submission remain the same. Long-term program milestones remain with a changing timetable consistent with market needs. Although detailed planning is still in progress, several major program features and activities have emerged. The most immediately visible change is that the AVLIS facilities in Oak Ridge will be shut down in FY 1986, nominally 1 year earlier than previously planned.

Integrated enrichment test schedules have been shortened and delayed about 6 months.

Estimated go-forward development, demonstration, and deployment costs for AVLIS are approximately $2.5 billion including the capital costs for an AVLIS production plant. These costs are not measurably altered by recent changes in the AVLIS development program.

ELECTRICITY DEMAND

Mr. Bevill. What is the Department's estimate of requirement for additional or replacement electrical generating capacity through the end of this century?

Secretary Herrington. The Department estimates that substantial amounts of new electrical generating capacity will be needed both to meet demand growth and to replace capacity which is obsolete.

The future rate of electric demand growth is highly uncertain. However, it appears likely that demand will grow at an average rate between 1 and 4 percent per year through the end of the century. Under this assumption, the nation will need up to 730 gigawatts of new electric generating capacity, beyond that which exists or is under construction, just to meet demand growth. If demand grows between 2 and 3 percent per year, as shown in many recent projections, between 30 and 150 gigawatts will be needed to meet demand growth through the end of the century. The requirements under different rates of demand growth are shown in a table I would like to insert in the record.

(The information follows:)

NEW GENERATING CAPACITY REQUIRED TO MEET DEMAND GROWTH

Annual Demand Growth	Supply Needed in 2000	Less: Supply Pipeline	Equals: New Supply to Meet Demand
1 percent	630 GW	700 GW	-70 GW
2 percent	730 GW	700 GW	30 GW
3 percent	850 GW	700 GW	150 GW
4 percent	980 GW	700 GW	280 GW

In addition, however, the nation will need substantial amounts of new electric supply to replace existing supply which becomes obsolete. Even if power plants are assumed to have a lifetime of 40 to 50 years, which is longer than the 30 years for which most plants are planned, retirements of existing capacity will amount to 20 to 110 gigawatts by the end of the century. In addition, roughly 50 gigawatts of supply will probably be needed to replace supply which is likely to be uneconomic because it relies on oil or gas for baseload power production.

Thus, depending on the rate of demand growth, the total need for new supply through 2000, beyond that which exists or is under construction, could be as high as 440 gigawatts. If demand grows between 2 and 3 percent per year, as shown in many recent projections, the need will probably be between 130 and 310 gigawatts through the end of the century. The combined requirements needed to meet demand growth and replace obsolete plants are shown in a table which I would like to insert for the record.

(The information follows:)

NEW GENERATING CAPACITY REQUIREMENTS FOR DEMAND GROWTH AND REPLACEMENT OF OBSOLETE PLANTS

Annual Demand Growth	Supply to Meet Demand	Plus: Replacement of Obsolete	Equals: Total New Supply Need
1 percent	-70 GW	70 to 180 GW	0 to 180 GW
2 percent	30 GW	70 to 180 GW	100 to 280 GW
3 percent	150 GW	70 to 180 GW	220 to 330 GW
4 percent	240 GW	70 to 180 GW	310 to 440 GW

Mr. Savitz. What is the capability of the United States, both public and private sectors, to address that demand?

Secretary Herrington. The amount of investment required for needed new electric supply is likely to be very substantial but still well within the nation's capability. If demand grows between 1 and 4 percent per year, the annual financing requirements for electric generation, transmission and distribution may be as high as $90 billion in 1982 dollars by the year 2000. This would be roughly 9 percent of the total investment in the economy as projected by Data Resources, Inc. If demand grows between 2 and 3 percent per year, as most recent projections indicate, the annual financing requirements are likely to total over $50 billion to $70 billion in 1982 dollars by 2000, or between 5 and 7 percent of total investment in the economy.

The need for new electric supply is likely to be met through investments of many different types. Supply options include not only conventional baseload power plants, but advanced coal technologies, renewables, utility-sponsored conservation and load management programs, an improved network of electric transmission lines, and participation in development of Canadian power facilities. Utilities and their regulators will be able to choose among these options as new supply is needed.

Mr. Quirk: Does the department anticipate electricity shortages at any time in the next 10 years?

Honourable Darlington: The service will have some additional amounts of new electric generating capacity beyond that which exists at the added requirements. It depends given between 3 and 5 percent per year, as to many recent projections, the service as a whole will need new supply by sometime between 1990 and 1995 just to meet demand growth.

Taking account of the need to replace capacity that is retired or unavailable, the service will need new supply by sometime between 1989 and 1993. Hydrous will might demand growth may need supply even sooner.

The department does not anticipate, however, that the beginning need for new electric supply implies widespread shortages of blackouts. There are certainly types of generating capacity, such as cogeneration facilities fueled by oil or gas, that can be built quickly with construction times not that the will should be urgent need arises. But there is a concern that sufficient may fail to build the mix of electric supply options that is likely to be most economic for consumers over the longer term.

ENERGY RESEARCH PROGRAMS

Mr. Bevill. Most of the Department's civilian energy research programs have been reduced in the FY 1987 budget. How does this relate to your objectives of meeting energy security needs?

Secretary Herrington. The best way to meet energy security needs is to let the market function. Government spending is not likely to materially affect energy security. The FY 1987 budget also reflects the need to meet fiscal goals and as such places a greater requirement to undertake the most cost-effective energy research programs that do not duplicate or compete with private sector activities. Therefore, our greatest emphasis has been on basic research and development rather than product development and demonstration. We are confident that our energy security needs are efficiently met under this research and development strategy and that our proposed FY 1987 budget is a successful realization of this strategy in terms of the research programs and funding levels that are recommended.

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NUCLEAR ENERGY RESEARCH

Mr. Bevill. What are the Department's priorities in nuclear energy research and how were they established? How have they changed since last year?

Mr. Herrington. The Department has provided R&D support for both the defense and civilian nuclear energy areas for decades and both areas will continue to be served by the proposed programs. It is our intent to integrate and coordinate those efforts to the maximum extent so as to minimize the overall cost. The priority of military programs has not changed; programs have expanded and moved ahead as planned while the overall funding stringencies have tightened. Two factors are at work. One is the decrease in orders by utilities for new nuclear generating capacity resulting in a relaxation, which may be temporary, of the urgency for advanced reactor technology for civilian service. The second is the emergence of the Strategic Defense Initiative and its multiple concepts for which advanced nuclear power technology is frequently the most advantageous choice to meet power source needs. In the face of the urgent need to reduce Government outlays, the Department has recommended an adjustment of the civilian reactor development capability to meet growing SDI needs rather than the buildup of a new separate and costly program capability unique to SDI applications.

Mr. Bevill. In FY 1986, the Congress directed and the Department agreed to undertake a selection process to identify future advanced reactor concepts. What is the current status of that initiative?

Mr. Herrington. In August 1985, I requested the Energy Research Advisory Board to establish an ad hoc panel to review and comment on the Office of Nuclear Energy's Draft Strategic Plan for the Civilian Reactor Development Program; that review is continuing.

The essence of DOE's draft Strategic Plan for Civilian Reactor Development is to establish an agenda of requisite actions and tasks to develop advanced reactor systems that can be acceptable and competitive in a future market. Included in that agenda is a process for evaluating innovative reactor concepts to identify one for enhanced development and possible demonstration.

While the pace of the program to fulfill that agenda must be adjusted to accommodate space and defense priorities and budget constraints, it is the Department's intent to continue to operate our unique reactor test facilities and conduct the R&D leading to advanced reactor systems at an appropriate time in the future. A revised Strategic Plan, based on consideration of comments received from the ERAB Panel, Congress and others, will be valuable in guiding and focusing DOE's civilian reactor development programs, in helping assure complementary efforts by the private and public sectors, and in maintaining goals and objectives to ensure effective utilization of funds. The revised Plan should be available this spring.

Mr. Bevill. What is the current outlook for civilian nuclear reactor plant orders in the United States for the next ten years?

Mr. Herrington. Few, if any, orders for new nuclear powerplants are likely to be placed by U.S. utilities during the next five to ten years. This is due to a low rate of growth in demand for electricity during the last decade and a complex combination of institutional, financial, and regulatory problems. The Department has urged the enactment of licensing reform legislation and completion of development of an advanced generation of light water reactors as important measures to pave the way for new powerplant orders in the 1990s. The program proposed in the President's FY 1987 budget to the Congress is intended to support those objectives.

MAGNETIC FUSION

Mr. Bevill. What are the Department's current priorities for the magnetic fusion research program?

Mr. Harrington. The Department's program is organized around four key technical issues: development of magnetic confinement systems, the science of burning plasma, development of fusion materials, and development of fusion nuclear technology. In the first area, budget constraints have forced us to focus on toroidal systems. In the second area, the Tokamak Fusion Test Reactor and the Doublet III are our main resources for learning the requirements for producing a burning plasma. In fusion materials and fusion nuclear technology, we are maintaining minimal programs to identify the requirements for future facilities and to prepare for international collaboration.

Mr. Bevill. What do you consider to be the proper role of the magnetic fusion research program in FY 1987 and beyond?

Mr. Harrington. The Department's goal is to provide the science and technology base for fusion energy. This requires addressing the four issues I mentioned previously. We plan to do so through a combination of a strong domestic program and effective international collaboration. We would like to have the information needed to assess the environmental and economic aspects of fusion applications by about the turn of the century. In the meantime, the Department's program also contributes to the nation's science and technology base and to the training of scientists and engineers for a wide variety of other endeavors.

NUCLEAR WASTE FUND

Mr. Bevill. In your view, Mr. Secretary, is the Department continuing to implement the provisions of the Nuclear Waste Policy Act (NWPA) in such a manner as to insure the completion of a final repository by 1998?

Secretary Herrington. The Department has pledged its best effort to meeting the 1998 date for the completion of the first repository. Admittedly, this is an aggressive, success-oriented schedule. We have taken longer than scheduled to complete some of the early milestones called for in the Act. However, I believe we have produced better-quality documents and completed actions that go beyond the minimum requirements that will enhance our ability to meet future program milestones.

Mr. Bevill. What, if any, delays are you aware of that could affect any of the deadlines imposed in the Act?

Secretary Herrington. As you know, Mr. Chairman, we submitted the Mission Plan to Congress in July of 1985. In the Plan we identified the dates when we completed some near-term actions since the Act was passed and dates when we expected to complete future actions. One of the key dates was November 1985 for the submittal of the Environmental Assessments (EAs) for the first repository sites. At the suggestion of several program participants, we requested the National Academy of Sciences to review the ranking methodology for the sites. Because of this review, we now expect to issue the EAs around the end of April.

In the next few weeks, we will be issuing the Project Decision Schedule which is required by the NWPA. The Project Decision Schedule will reflect the impact of the new date on the future milestones required by the NWPA.

I would also like to point out that the Department has been enjoined from making any proposal or filing any documents with Congress on the Monitored Retrievable Storage facility which rely on the siting studies performed in conjunction with the proposal preparation process. We have appealed the injunction and we are hopeful that we will receive a speedy resolution of the legal issues involved so that we can submit the proposal.

Mr. Bevill. What changes have occurred in FY 1985 and 1986 in the Nuclear Waste Disposal program?

Secretary Herrington. There have been no major changes in the program. The approach we are following is still the same as that spelled out in the Mission Plan which we submitted to Congress in July of 1985, although we are rescheduling some of the dates, as discussed above.

SOLAR ENERGY PROGRAM

Mr. Bevill. Does the decline in world oil prices make solar energy options so economically unattractive that further reductions in solar research should be made?

Secretary Herrington. The continuing decline in world oil prices has had a number of effects upon the domestic economy, the domestic energy industry, and upon the competitive timeliness of individual energy technologies; including solar. It remains the Department's view that the energy requirements of the Nation continue to be served by public and private investment in technologies capable of employing indigenous resources such as solar energy to promote additional diversity within the domestic energy supply system. Solar energy technologies have become locally or regionally important ingredients of the energy supply mix, and have the potential for becoming increasingly significant at the national level over the long term. The Department's budget recommendations for solar energy are formulated with an eye toward preparing for the long term viability of solar options through cross-cutting research while reducing Federal expenditures wherever possible and focussing outlays on the type of basic research suitable for public investment.

Mr. Bevill. What role in the Nation's total energy requirements will solar energy take in the next 15 years?

Secretary Herrington. The difficulty of attempting to make dependable forecasts in a highly unpredictable future has been discussed within the

energy community on numerous occasions and remains a valid consideration. From the information available to the Department it appears that renewable energy, which was contributing some 8 to 8.5 percent of national primary energy supply in 1984, may represent some 10 to 10.5 percent of the supply mix by the year 2000 and may reach 13 to 14 percent of domestic primary energy supply by the 2010 timeframe. These estimates, of course, reflect a number of highly uncertain economic and energy assumptions and additionally presume that research will prove successful and that industry will be successful in introducing commercial technology into the competitive marketplace.

BUY AMERICA

Mr. Bevill. The FY 1986 Appropriation Act contains a statutory "Buy America" provision. What has the Department done to implement this policy?

Mr. Herrington. The power marketing administrations are cognizant of the 1 year provision and, if funded by appropriations under Public Law 99-141, are required to comply with these provisions if extra high voltage equipment is to be procured. Implementation of this policy will be accomplished using existing Federal Acquisition Regulations.

Mr. Bevill. What has been the experience to date with this provision?

Mr. Herrington. To date this fiscal year, the Western Area Power Administration has not made any procurements for EHV equipment. However, they plan to issue a procurement solicitation this spring for EHV equipment totaling approximately $9 million. Southeastern, Southwestern, and Alaska Power Administrations have not purchased any extra high voltage equipment thus far in FY 1986 and d not foresee any procurement in the near future.

The Bonneville Power Administration, is not funded by appropriation and is not directly covered by this provision. However, under the definitions of the "Buy America" provisions, 96 percent of BPA's $58 million for power system apparatus and materials to date in fiscal year 1986 have been to firms certifying domestic end products. For all of fiscal year 1985, BPA purchased domestically certified end products amounting to 87 percent of the approximately 25 million of total dollars spent for power system apparatus and materials. However, it must be noted that products certified as domstic can

and usually do contain a foreign component.

DEFEDERALIZATION LEGISLATION

Mr. Bevill. The FY 1987 budget assumes a change in the procedures for determining repayment rates for the Power Marketing Administrations. The budget also assumes selling the Power Marketing Administrations. Is it the position of the Administration that these actions will not be implemented without the enactment of authorizing legislation?

Mr. Herrington. Yes. The Department recognizes that Congressional approval will be required prior to sale and that legislation will be proposed to give the Congress an opportunity to review the investment repayment proposal.

PMA LEGISLATION

Mr. Bevill. What is the status of the Administration's legislative proposals for both the rate reform and the sale of the Power Marketing Administrations?

Mr. Herrington. With respect to repayment reform, the Department intends to forward a legislative proposal in the near future. The Department intends to pursue defederalization through an open, competitive process. Task

Groups will be established to look at all possible options. Before implementation of defederalization, we will seek the views of concerned groups and individuals including Congressional delegations, State and local officials, current customers, the financial community, and public power and private sector energy interests.

The Department clearly recognizes that Congressional approval will be required prior to sale. The legislative language ultimately submitted to the Congress will reflect the Administration sale proposal alternative which best conforms to the guidelines for sale.

DEFEDERALIZATION SCHEDULE

Mr. Bevill. Please provide a schedule showing when the sale of the PMAs is anticipated and show the anticipated revenues by PMA by year.

Mr. Herrington. Although the actual schedule may well differ from the projected schedule in the President's fiscal year 1987 budget, the projected schedule for defederalizing the PMAs is in a table I would like to insert for the record.

(The information follows:)

1987 Budget Proposals — Revenue from Defederalization

(Revenues -- $ in Millions)

	1987	1988	1989	1990	1991	Total
Proceeds from Sale of Assets*						
Bonneville	--	1,000	1,000	3,425	3,425	8,850
Alaska	--	--	--	174	--	174
Southeastern	--	--	--	--	1,383	1,383
Southwestern	--	800	--	--	--	800
Western Area	--	--	500	2,172	--	2,672
Subtotal	--	1,800	1,500	5,771	4,808	13,879

* Proceeds from sale of assets do not address foregone revenues.

VALUE OF THE PMAs

Mr. Bevill. What are the anticipated revenues from the sale of each of the Power Marketing Administrations and how is the Federal "worth" of each determined?

Mr. Herrington. The current assumption is that the sale price would be the amount of the unpaid Federal investment at the time of sale. We fully recognize that the actual sales price and timing of the sales could differ from current projections. Anticipated proceeds from the sale are approximately $13.9 billion assuming completion of sale of Power Marketing Administrations by 1991. We expect to examine the revenues issue very closely in developing our detailed defederalization plans.

MODIFIED RATE REFORM

Mr. Bevill. Please describe how the rate reform proposed for FY 1987 differs from the proposal of FY 1986.

Mr. Herrington. The FY 1986 proposal called for repayment of the appropriated principal at a level not less than would be required under straight-line amortization for both power and irrigation. The FY 1987 proposal would exempt irrigation repayment from this requirement. The FY 1986 proposal would have required that the interest rate to be applied to the entire unpaid principal, including irrigation, be based on the average yield (based on average daily bid prices during the preceding fiscal year) on interest-bearing marketable securities of the United States which have terms of 15 years or more remaining to maturity. The FY 1987 proposal would not change the interest rates on appropriated investments made prior to October 1, 1986, and would not impose interest on unpaid irrigation principal. The FY 1987 proposal would impose a current interest charge when scheduled principal payments are deferred because the deferral helps to finance current operations.

PMA RATES

Mr. Bevill. Please provide a table showing the rates for each Power Marketing Administration for FY 1985, FY 1986, and FY 1987. For FY 1987 please show the anticipated rates assuming the implementation of the changes and the rate without the changes being proposed.

Mr. Herrington. The wholesale electric power rates in effect for each of the Federal Power Marketing Administrations for FY 1985 and FY 1986, and the estimated wholesale electric rate that could occur both with and without repayment reform are inserted for the record. Any final rates implemented during FY 1987 would be subject to public review and Federal Energy Regulatory Commission approval.

(The information follows:)

BONNEVILLE POWER ADMINISTRATION
AVERAGE RATES
(mill/kWh)

	FY 1985 1/	FY 1986	FY 1987	
			Without Repayment Proposal	With Repayment Proposal 2/
Priority Firm Power Rate (PF)	22.1	22.2	22.2	24.0
Industrial Firm Power (IP) Standard Rate	25.7	22.8	22.8	22.8
Surplus Firm Power Rate (SP/SE)	30.8	29.9	29.9	29.9
Nonfirm Energy Standard Rate (NF)	19.7	23.4	23.4	23.4

1/ Current rates put into effect July 1, 1985. Therefore, FY 1985 rates represent 75 percent of 1983 rate plus 25 percent of 1985 rate.

2/ Preliminary estimates. Assumes that BPA could raise FY 1987 rates if legislation revising the repayment methodology were enacted and the straight-line proposal went into effect on October 1, 1986, and that the entire increase would fall on the PF Rate. It tentatively appears that other rates would not increase in FY 1987 because of a floor rate in effect for the Direct Service Industrial (DSI) customers that keeps the IP rate higher in the near-term than it would be otherwise, and because of market conditions for SP and NF sales. Under existing law, BPA's DSI customers could not be completely sheltered from some rate increases resulting from implementation of this proposal. For example, it is possible that an increase could be required if there is a revenue shortfall due to (1) continuous low aluminum prices and (2) the sudden rapid decrease in oil and gas prices, affecting BPA's export markets.

Wholesale Electric Rates

(mills per kilowatthour)

PMA	FY 1985	FY 1986	FY 1987	
			Without Repayment Proposal	With Repayment Proposal
Alaska Power Administration				
(1) Snettisham	25	25	28	32
(2) Eklutna	19	19	19	19
Bonneville Power Administration		(table attached)		
Southeastern	15	16.4	17.5	19.2
Southwestern	27.5	27.4	27.5	30.5
Western Area	12.9	15.4	16.6	16.6

PMA REPORTING

Mr. Bevill. Under the present organization of the Department, BPA and WAPA report directly to the Secretary while SWPA, SEPA, and Alaska report to the Assistant Secretary for Conservation and Renewables. Do you plan to continue this organization? What are the benefits of this organization?

Mr. Herrington. Yes. The present reporting relationship of the PMAs recognize the more complex roles and operating characteristics of Bonneville and Western Area Power Administration which are comparable to the eight operations offices of the Department that also report directly to the Office of the Secretary. This reporting relationship of BPA and WAPA reflects a management view of the nature of oversight desired and permits an appropriate level of responsiveness to the interests being served.

Mr. Bevill. What is the status of the Superconducting Super Collider project?

Mr. Herrington. R&D on the SSC is progressing well and has had significant successes. The SSC Central Design Group, with participation from the laboratories, universities and industry, is in the final stages of preparation of a detailed Conceptual Design Report. This report will contain a fully consistent design, with costs and schedule, based on the results of the R&D program. The Department, using this input, will conduct a very thorough review this spring of the entire scientific, technical and cost aspects of the SSC. This review will serve as important input to the Department's decision this summer on whether to seek authorization to initiate construction of the project in FY 1988.

Mr. Bevill. Your FY 1987 budget does not include any funds for the Superconducting Super Collider pending a review in FY 1986. If this review results in a positive determination with regard to the project, do you anticipate submitting a supplemental request?

Mr. Herrington. There is funding in the FY 1987 request for High Energy Physics accelerator R&D. The direction and emphasis of this R&D, especially the work on superconducting accelerator magnets and associated systems, will

depend on the results of the review this summer. It is premature to assign a specific number to SSC R&D in FY 1987. However, at this time we do not anticipate submission of a request for supplemental funding for the High Energy Physics program.

Mr. Bevill. Does the lack of budgeted funds in FY 1987 portray a significant reduction in Administration support?

Mr. Herrington. Not at all, we view the SSC as an outstanding project. We plan an indepth review of the project and the establishment of program priorities before making specific commitment of funds for SSC R&D in FY 1987.

Mr. Bevill. What is the status of the various State proposals for the Superconducting Super Collider?

Mr. Herrington. The Department has not requested SSC site proposals and has no mechanism for monitoring the State activities. The ad hoc information we have received indicates much interest and a wide range of activity.

Mr. Bevill. If a decision is made to proceed with the Superconducting Super Collider, what would you anticipate the funding requirements to be for FY 1987 and FY 1988?

Mr. Herrington. We believe that by focusing on the most critical SSC requirements, the incremental FY 1987 needs for SSC R&D could be accommodated within the FY 1987 request. It is premature to speculate on the FY 1988 funding requirements. However, if we were to proceed in FY 1988, I would anticipate a relatively slow start since that would be the period during which site proposals would be prepared, submitted, and evaluated.

ATOMIC ENERGY DEFENSE ACTIVITIES

Mr. Bevill. Your FY 1987 budget assumes a 14% increase in Atomic Energy Defense Activities and significant decreases in nearly all of other Department programs. Please describe this priority.

Secretary Herrington. While this increase appears to be large it should be noted that as a result of the reductions necessitated by the Gramm-Rudman legislation, the FY 1986 revised appropriations level is actually lower than the FY 1985 appropriation for Atomic Energy Defense Activities. The FY 1987 request of $8.1 billion for this appropriation essentially restores the funding levels for these high priority national security programs to approximately the FY 1985 level of activity, after adjusting for inflation. These funds are necessary if the Department is to continue to meet its essential national security responsibilities for producing nuclear weapons systems and supporting the national priority effort on the Strategic Defense Initiative. Also within our total available resources, we must accommodate other critical defense activities such as the continuation of a strong research and development base technology effort, the maintenance and restoration of our production plants, the revitalization of our research and development facilities, and the continued allocation of resources to accommodate priority requirements associated with safeguarding the Department's facilities and materials, and assuring that environmental and safety concerns are quickly detected and corrected in a responsible and cost effective manner.

Mr. Bevill. Your FY 1987 budget for Atomic Energy Defense Activities has been depicted as allowing a 3% real growth after allowing 5% for inflation and 5% for the FY 1986 Gramm-Rudman reduction. Do you feel that the intention of the Gramm-Rudman legislation was to refund sequestered funds? Does your budget request for FY 1987 include any nondefense funding that was sequestered in FY 1986?

Secretary Herrington. The Departments' FY 1987 budget request was not intended to "refund" or in someway subvert the impact of the Gramm-Rudman legislation but was developed to fund the highest priority activities while remaining within overall target specified by that legislation.

FUELS AND MATERIALS EXAMINATION FACILITY

Mr. Bevill. Why is FMEF on the list of terminated projects?

Mr. Herrington. It is imprecise to have the Fuels and Materials Examination Facility identified on any list of terminated projects. Major construction of the FMEF was completed in October 1984. This accomplishment was achieved utilizing funds appropriated for the project through FY 1983. Currently, equipment components for the Secure Automated Fabrication line, which were not part of the FMEF project, are being installed in the facility. Other previously planned installations (e.g., the Breeder Reprocessing Engineering Test, BRET) in the FMEF building have been indefinitely deferred.

Mr. Bevill. What is the function of FMEF?

Mr. Herrington. The Fuels and Materials Examination Facility includes facility capability for the fabrication of fuel pins and fuel assemblies for the Fast Flux Test Facility. When the facility is fully operational in FY 1988, it will be the only facility in the United States for production of mixed-oxide fuel. The FMEF, with its advanced safeguards systems, will enable consolidation of fuel activities at the Hanford Engineering Development Laboratory to provide more efficient and secure operations.

Mr. Bevill. Could FMEF remain operative if FFTF was closed?

Mr. Herrington. Yes. However, the Department would have to assess whether it makes sense to operate the Fuels and Materials Examination Facility under such a circumstance. Uses for other DOE missions, international collaboration, and need for domestic mixed-oxide fuel supply would be major considerations in determining the future of FMEF in the event the Fast Flux Test Facility were closed.

MFTF-B

Mr. Bevill. Describe the current status of the project with respect to completion of construction--with respect to readiness for operations.

Mr. Herrington. The MFTF-B project is completed. The superconducting magnets have all been operated simultaneously at full field under computer control. The 190 foot, 3 million pound tank was under vacuum, and all the various power supplies worked well. As for being ready for operation, the plans that were made during better financial times for the magnetic fusion program called for diagnostics, neutral beams and intense microwave systems to be installed in FY 1987 and experiments to begin in FY 1988. So MFTF-B is not quite ready for operation at this time.

Mr. Bevill. Discuss options under consideration for MFTF-B, i.e., termination, mothballing, limited operations, etc. What funds will be used to correct potential design shortcomings if MFTF-B is completed?

Mr. Herrington. The present plan is to mothball MFTF-B and explore the possibility of international collaboration on it in the future. No funds will be used to correct a "potential design shortcoming." In fact, there are no "potential design shortcomings." The magnets have all been tested. In addition, this device is a physics test facility. It has been made flexible and can be run in many modes by using neutral beams and RF sources. The MFTF-B was designed to do a physics test of tandem mirror scaling and there are no technical reasons why it could not do this test. MFTF-B could be operated as designed.

Mr. Bevill. What is the estimated annual operating cost for MFTF-B?

Mr. Harrington. LLNL has calculated that MFTF-B can be operated for $55M a year. In FY 1987, $30M would be needed to support the staff and to install diagnostics, neutral beams, and RF sources. An amount of $35M would be needed in FY 1988 for experimental operations using the 1/2 second intense beam sources. Additional funds would be required to install 30 second capability.

Mr. Bevill. Is it possible LLNL knew about its design problems on MFTF-B for 2 years before its disclosure? Is there legal recourse against anyone for MFTF-B's design problems? If not, why not?

Mr. Harrington. To our knowledge, there are no "design problems" with MFTF-B. All systems worked well when tested upon completion of construction. Because there were no design problems, legal recourse was not necessary.

Mr. Bevill. Are there any estimates available for the costs to engineer new magnet configurations for MFTF-B, if the present design is inappropriate?

Mr. Harrington. The design of the magnets is adequate to operate MFTF-B as planned. Thus no costs are anticipated. If MFTF-B were to be operated, it could be run in several modes with the present magnet set. Any magnet changes would be made only after smaller tandem mirror devices showed new and exciting improved operation regimes. No costs are anticipated.

BUILDING 371

Mr. Bevill. Building 371 - Rocky Flats was approved by the Congress in 1970 with an estimated project cost of $113 million. Its original schedule reflected a completion date of December 1975. However, this date slipped several times and the project was finally "completed" in August 1981 with a cost overrun of approximately $102 million (total project cost of $215 million). The completed project was only able to operate at about 8 percent of design capacity and as a result, at least two alternatives have been developed to "retrofit" the facility. One plan would cost $295 million, but the facility will only operate at about 58 percent capacity. The other alternative would cost $563 million with an 87.5 percent operating capacity. Work cannot begin until FY 1988 and will take approximately 6 years to complete. Why is there such a large discrepancy between the two cost estimates for the retrofit?

Secretary Herrington. The $295 and $563 million figures quoted do not represent cost estimates solely for the modification of Building 371. At the time those figures were estimated, a study to assess the required capacity for plutonium recovery at Rocky Flats Plant was underway. The two figures represent lower and upper estimates on capital costs to modify Building 371 and operating costs to continue plutonium recovery at Rocky Flats and other facilities. These costs are dependent on the outcome of the study. Based upon DOE guidance, Rockwell International has prepared a Conceptual Design Report (CDR) for a modification project. The DOE is reviewing the design report and has made no decision yet.

Mr. Bevill. How long will it take the Government to amortize its total investment in Building 371, using: a. DOE's estimate for cost and production? b. Rockwell's estimate for cost and production?

Secretary Herrington. Of the alternatives being considered for providing the DOE with a reliable and efficient plutonium recovery capability, a definitive estimate is available only for the full and complete modification of Building 371. At this time, a preliminary estimate based upon a completed conceptual design report (CDR) is available only for the full and complete modification of Building 371. The CDR cost estimate is approximately $331 million. I must emphasize again, however, that this estimate is preliminary and that no final decisions have been reached.

Recovery of the total investment in Building 371 including the original investment, modification costs, and on-going operational costs would occur in several years given the high dollar value of the material recovered.

Mr. Bevill. If the retrofit is completed, will the facility meet original design specifications? What would have to be done to achieve a 100 percent operating capacity?

Secretary Herrington. The original design specifications were intended to meet then current operating requirements in many areas, including nuclear material safeguards and radiation protection. The design specifications for the modification of Building 371 may be significantly different from the original ones. Current design specifications are directed toward providing a cost-effective facility that will support current and anticipated requirements to recover plutonium from all Rocky Flats-generated residues and meet current and anticipated future radiation protection and nuclear materials safeguards requirements which are more stringent than those required at the time of the original design. Any modification project will be based on current and forecasted requirements.

Mr. Bevill. Is there a chance the retrofit cannot correct the problems? Would there be legal recourse if it cannot? Would building a new facility be a safer option?

Secretary Herrington. By implementing lessons learned from the original project in the areas of project management, planning, staffing, technology and engineering development and demonstration, and engineering and project management control systems, the risks associated with the potential modification have been judged to be low. With respect to legal recourse, any liability for a modification of Building 371 would have to be based on proof that the contractor's managerial personnel were guilty of willful misconduct or lack of good faith with respect to the contractor's involvement in the modification of Building 371. Obtaining a contract which includes performance guarantees would be extremely costly. The risks associated with the modification of Building 371 are not considered any different from those associated with starting over with a new facility.

Mr. Bevill. Describe the options being considered for Building 371 and include each option's estimated cost, schedule, and anticipated production compared to the original production goals?

Secretary Herrington. The DOE is reviewing the Rockwell Conceptual Design Report mentioned above for the modification of Building 371. This conceptual design incorporates: recovery capacity of less than the original Building 371 project; one that will meet projected requirements; reliance on proven technology; radiation protection in full compliance with current and anticipated exposure criteria; and nuclear materials safeguards capabilities. The estimated cost included in the conceptual design is $331.5 million and construction could require seven years to complete. The DOE has not completed its assessment of the conceptual design and may make changes in the criteria for the advanced design, the cost estimate, and the schedule. In addition, the DOE is considering other alternatives involving plutonium recovery at other DOE facilities.

URANIUM ENRICHMENT

Mr. Myers. What do you propose with respect to advance technology in Uranium enrichment? How does your current plan compare to the plan last year? What do you think the chances are of shifting AVLIS deployment to the private sector, as far as Congress is concerned?

Mr. Herrington. We want to encourage private sector participation and financial support as soon as practical in the AVLIS program. The program is presently structured so that it can be deployed from a firm demonstration base. Of course, market factors and other conditions would have to be favorable to support such an undertaking.

AVLIS program goals remain the same, although program milestones have been delayed. In the near term, we plan several changes in the structure of the program. First, the AVLIS Oak Ridge facilities will be shut down in FY 1986, about 1 year earlier than previously planned. We will delay and shorten the integrated enrichment test schedules by several months. Go-forward costs for AVLIS development, demonstration, and deployment remain approximately $2.5 billion, however.

At this time, we are unable to quantify the degree of private sector interest that would develop from an AVLIS privatization initiative. However, the Department is taking steps to address this by developing a process for seeking expressions of interest from private organizations and by initiating industrial access into the AVLIS technology.

INTERNATIONAL COLLABORATION ON FUSION

Mr. Myers. What exactly did the President and Premier Gorbachev agree to with respect to international collaboration on fusion energy? Is this initiative consistent with the Appropriations Committee direction that the Department seek international collaboration?

Mr. Herrington. President Reagan and General Secretary Gorbachev agreed to the following statement on fusion at the Geneva Summit. "The two leaders emphasized the potential importance of the work aimed at utilizing controlled thermonuclear fusion for peaceful purposes and, in this connection, advocated the widest practicable development of international cooperation in obtaining this source of energy, which is essentially inexhaustible, for the benefit of all mankind." The United States Government is now developing a specific course of action to discuss with the Soviets as detailed follow through on the Geneva statement. We are also seeking our allies views on a multinational fusion cooperation.

This initiative is fully consistent with the Appropriations Committee direction that the Department seek international collaboration. The Department has been doing that through the joint planning activities begun by the Economic Summit's Working Group on Controlled Thermonuclear Fusion. Dr. A. W. Trivelpiece, Director of Energy Research, is the co-chair of this Fusion Working Group. The Geneva Summit Initiative is fully consistent with this planning and strengthens the focus on the technical issues. Involvement of the four parties (U.S., EC, Japan, and the USSR) would strengthen international fusion collaboration by bringing additional highly skilled personnel to the joint efforts and reduce costs for the participating governments.

DEFENSE PROGRAMS

Mrs. Boggs. What is the dollar amount of funding in this budget for support of the Strategic Defense Initiative?

Secretary Herrington. The FY 1987 defense programs budget estimate for strategic defense activities is $536 million.

Mrs. Boggs. Are any of your SDI-support funds to be used for research on nuclear weapons in space or nuclear-powered weapons for the SDI program?

Secretary Herrington. Yes, the Department of Energy conducts research on the technical feasibility of concepts using nuclear explosions to power directed energy weapons against ballistic missile attack primarily to assess adversary threat. It has done so since the late 1970's. As you know, the Soviets have no self-imposed constraints on the development of such weapons and we must assess their capability of developing defensive and counterdefensive nuclear directed energy weapons. The only way we can credibly make this assessment is by conducting this nuclear directed energy weapon research.

While it is technically possible that strategic defense architectures could include nuclear directed energy weapons, it must be noted that the President's SDI policy calls for nonnuclear architectures and we fully support that policy. Also, SDI work at DOE is strictly a research program.

Mrs. Boggs. Has anyone told the President that the SDI program, in fact, does involve nuclear activities?

Secretary Herrington. Yes, the President is aware of our nuclear directed energy weapon research. As you may know, it is the Department of Energy's responsibility to conduct nuclear research to avoid technological surprise by the Soviets which is so vital to preserving our National security.

FUSION

Mrs. Bogge. What impact has Gramm-Rudman had on the Department's research and development programs particularly the fusion program?

- Mr. Herrington. The Department has applied the Gramm-Rudman reductions for FY 1986 in the most uniform manner possible consistent with the terms of the Balanced Budget and Emergency Deficit Control Act of 1985. The specific impact varies slightly from program to program and contractor to contractor. The general impact involves the layoffs or short furloughs of some personnel, delays in ordering materials and supplies, and the shutdown of some research facilities for a short period of time. The specific reduction of about $14 million in the magnetic fusion program has elements of all the above impacts.

DEFINITION OF DEFEDERALIZATION

Ms. Boggs. Why do you use the term "defederalization" in conjunction with the sale of the power marketing authorities as opposed to the term "privatization" which seems to be more popular with OMB?

Mr. Herrington. Privatization is utilized in the broad sense. I have used the term "defederalization" to describe this initiative and perhaps it more accurately conveys our intent. In our view, the new owners could be either public or private.

Ms. Boggs. For the record, could you provide the Federal investment (in 1985) dollars in each of the power marketing authorities proposed for "defederalization"?

Mr. Herrington. In regard to the culmulative repayable investment at the end of FY 1985, I would like to insert a table for the record.

(The information follows:)

Repayable Investment at End of FY 1985

PMA	Amount
Alaska	$ 131
Bonneville	$9,374
Southwestern	$1,303
Southeastern	$ 839
Western Area	$4,148
	$ 15,795

Ms. Boggs. Could you please tell us what interest has been expressed in the "nonfederal" sector about the purchase of the PMAs.

Mr. Herrington. There have been areas of informal interst thus far. However, we are still at a very early stage of the sale process, so we do not have any detailed specific proposals for slae of the Power Marketing Administrations at this time.

Ms. Boggs. Since many private utilities around the country are experiencing financial problems and there is some speculation that the market has been over built, can you assure me that the "defederalization" won't really mean fire sale prices for these Federal assets?

Mr. Herrington. Ms. Boggs, let me assure you that defederalization of each PMA will be treated separately in a careful and sensitive manner. Defederalization will be pursued in an open, competitive process, but procedures for determining a fair price have not yet been determined. You can be assured that each sale will fairly balance the interests of the taxpayers and the interests of power customers.

Mr. Fazio. What is the schedule by which states or other entities will be notified of the conditions for application for the SSC, and when will the applications be due?

Mr. Herrington. No request for SSC site proposals will be issued until such time as the Department has committed to proceeding with the project and Congressional hearings on the project have been held. The possible timing for the request will be addressed as part of the Department's review of the project this spring and summer.

Mr. Fazio. Will the Department see what cost sharing and other benefits partners might be willing to contribute before it decides whether to proceed?

Mr. Herrington. We do not anticipate holding up the decision to proceed in order to determine possible contributions from nonfederal sources. We believe that participation of one sort or another is probable from both international and state sources, however, such participation is best explored once the project is established.

Mr. Fazio. The report due this summer is to be a technical and cost review, non-site specific design of an SSC. It is not intended to outline further R&D requirements. Yet your testimony indicates you will reprogram, or somehow find, new R&D funds if there is a need for more R&D. How will we know about new R&D needs if this report does not deal with that issue?

Mr. Herrington. Sufficient R&D information will be available this spring and summer for a decision on whether to seek authorization to initiate construction in FY 1988. Additional research and development work on the magnets and systems will be needed in FY 1987. This will include important participation by industry in the superconducting magnet R&D effort to incorporate further cost saving ideas and manufacturing techniques as well as enhanced technology transfer between the laboratories and industry. In addition, it is important that the full-length magnet prototypes presently being assembled be connected together to test the systems designs and further improvements will be made to the superconducting wire.

MFTF-B

Mr. Fazio. What would a sound basic operating level for the MFTF machine be in FY 1987?

Mr. Herrington. In order to operate MFTF-B as a tandem mirror, a year of further preparation is required during which the neutral beams would be installed, the ECH system added, and plasma diagnostics fabricated and installed. This preparation could be carried out at a cost of $30M in FY 1987, with MFTF-B plasma experiments started in FY 1988. An amount of $15M has been requested for MFTF-B "mothballing," so additional funds of $35M would be needed in FY 1987.

DEFEDERALIZATION

Mr. Fazio. Do you really think there will be any net savings to the budget from selling off the Power Marketing Administrations?

Mr. Herrington. Over the 5-year period of FY 1987-1991, based upon current assumptions, defederalization of the power marketing administrations will contribute $13,879 million towards deficit reduction. This would be offset by $1,888 million of future foregone revenues.

Mr. Fazio. Do you really think there is no public interest role for the Federal Government to play in the interregional distribution of power? At a time when new generation is getting more expensive, and when transmission is increasingly important, should we be blithely getting out of the business?

Mr. Herrington. Utilities are not normally a Federal responsibility, and we believe non-Federal owners can operate the Power Marketing Administrations as efficiently, or more efficiently, than the Federal government. The Administration believes the proper responsibilities of the Federal government are to provide for the common defense, conduct foreign policy, administer a system of justice, and provide other services that benefit the nation as a whole.

We further believe we need to scale back the role of the Federal Government to those activities that are most appropriately Federal in character. Thus, we can best contribute to the general welfare by allowing regional activities of a commercial business nature to be run by people and institutions within those regions.

Mr. Fazio. How will it help the national economy to recycle the investment in these facilities back onto the credit markets at higher interest rates?

Mr. Herrington. Based on current assumptions, defederalization of the power marketing administrations would contribute approximately $13,879 million for the purpose of reducing the Federal deficit. This will reduce the Federal deficit when the revenues are received and, furthermore, will reduce further Treasury interest costs of refinancing low interest rate appropriated investments that otherwise would be refinanced at current interest rates.

DEVELOPMENT OF NUCLEAR TECHNOLOGIES

Mr. Fazio. Since existing nuclear technologies were entirely developed by Government, does DOE really think that alternative technologies will somehow be developed by the private sector alone?

Mr. Herrington. We do not believe that alternative technologies will be developed by the private sector alone unless there is an immediate or near-term payoff. In the case of the High Temperature Gas Reactor (HTGR), a near-term payback is not indicated on the investment required by private parties to commercialize the HTGR reactor system.

Recognizing the role of the Department of Energy in the development of long-term energy sources, we have continued to support the HTGR in the FY 1987 budget. Our R&D efforts focus on resolving critical issues affecting the future commercial potential of the HTGR, namely: the potential of natural circulation cooling, tests on magnetic bearings, fuels studies to verify calculated performance, and regulatory issues affecting concept licensing.

It is in the national interest to make more efficient utilization of this Nation's energy resources, and the unique capability of the HTGR to provide high temperature process heat is a justification for continuing activity in this concept. We see eventual longer-term payoff here. Partnerships can be forged between the Department and private interests, and therefore we will continue to work closely with utility organizations and our contractors to develop a viable product that will have application in the electricity, congeneration and process heat markets.

NUCLEAR GENERATION CAPACITY

Mr. Fazio. What nuclear generation capacity do you believe we will have available for this country by 1995?

Mr. Herrington. Assuming all of the 30 nuclear units with construction permits and the 2 units currently on order without construction permits are completed, the total United States' capacity by 1995 would be approximately 120,000 megawatts electric. However, 12 of the 30 units with construction permits have had their construction indefinitely deferred or halted, and it is uncertain how many of these and the 2 units currently on order will be completed. For this reason, the total United States' nuclear generation capacity by 1995 will be less than 120,000 megawatts electric, most probably between 100,000 and 110,000 megawatts electric. This will represent approximately 15 to 20 percent of the total electric generating capacity in the United States, depending upon the number of plants completed and the growth in electric demand.

WIND ENERGY

Mr. Fazio. Another in the list of wasted facilities would be the Department's proposal to abandon the MOD 5 wind machine as it nears completion. You requested deferral of our $10 million 1986 fiscal year appropriation. The intent is obviously to kill this program, as it is with many of your alleged deferrals, by destroying the relationship with the program contractor. Where is the value in simply throwing this machine out?

Secretary Herrington. Much has been learned about large wind turbines from the extensive testing of the Mod-2 turbines located at Goldendale, Washington. This data and results of Mod-5 engineering and design studies will be available to the wind industry. Approximately $15 million can be saved by discontinuing the Mod-5 program. The more generic research supported in the Departmental Budget Request is of higher priority and will benefit a broader crossection of industry than would proceeding with installation and testing of a single piece of hardware.

RENEWABLE CUTS

Mr. Fazio. I am particularly concerned at the contempt in which the Department holds renewable funding, down 50 per cent in your proposal to $180 million. This is a typical decrease for this area. Renewables are as easy to ridicule as any energy form, but not really much easier. Of all the alternatives facing us in the mid-70's, renewables have actually come closest to the supposedly pie-in-the-sky projections we had for them. My principle utility in California has set a goal of having 3000 megawatts of renewable energy on line within 18 years. Yet clearly for some of them, a cooperative research and development will be needed to maximize their potential, something the Japanese do, something almost every nation does, something we once did with light water reactors, and something which we no longer do for reasons which will seem almost inconceivably archaic--quaint, naive-- to the generations that will inherit results of our inaction.

Why are renewables cut in half when most other accounts are reduced only 10-12% per cent?

Secretary Herrington. In each of the applied research and development areas, the need to accomplish reduced Federal outlays has prompted us to critically examine and prioritize every funding proposal. No area of technology has escaped this review process, and several others will be reduced by percentages similar to renewables. In the case of renewable energy, the proposed reductions in new budget authority reflect a variety of considerations including the successful completion of previous lines of research, a focussing of public investment in the more basic areas most

appropriate to the Federal role in technology research, and tough business decisions among competing technical priorities. The Departmental request for renewable energy reflects a commitment to sustaining a balanced effort among the renewable energy technology options in a manner which focusses expenditures on the highest priority scientific and technical investigations.

SLIDING OIL PRICES

Mr. Fazio. Isn't the oil price slide really a symptom of the underlying unreliability of the energy market?

Secretary Herrington. Rather than being a symptom of underlying unreliability of the energy market, I believe the recent oil price decline is an indication that the world oil market is behaving reasonably. With about 10 million barrels per day of excess capacity worldwide, oil prices were too high. The current steep decline of oil prices is more a consequence of certain OPEC members having cut production too deeply. Markets adjust as circumstances change; were we to attempt a non-market solution, we could see a replay of the gasoline lines and shortages that occured repeatedly in the 1970's.

RELATIONSHIP BETWEEN NEW GENERATION AND DOE BUDGET

Mr. Fazio. When we really do not appear to have significant new generation sources coming on line for the 1990's, is it wise to have reduced civilian energy from 57 per cent of the Department's budget in 1981 to 29 percent today?

Secretary Herrington. It is true that there is relatively little new generating capacity under construction at present, and that this condition could become a cause for concern if it persists for long in the face of continued demand growth. However, the electric utility industry's reluctance to undertake new construction projects reflects fundamental imbalances between the potential risks and rewards associated with such investments under our current regulatory arrangements, not the size of the Department's civilian energy budget.

To remedy some of these problems, the Department has endorsed the Nuclear Licensing Reform Act of 1985, standardized designs for nuclear plants, site banking, and the consideration of regulatory changes to facilitate competition in bulk power markets.

The Department's budget request for Fiscal Year 1987 has been tightly focused on long-term, high-risk, potentially high-yield, civilian R&D programs that the private sector cannot carry out due to excessive technical or economic risk. As the deficit is reduced in compliance with the requirements of Gramm-Rudman-Hollings, this is the most appropriate role for the Department to play.

ENERGY POLICY

Mr. Fazio. The Administration has been lucky with oil prices; it inherited the downfall of that which had gone up. To the extent deregulation of the domestic oil and gas markets contributed to loosening OPEC's grip, the hard deregulation decisions were made by the preceeding administration. That is the only policy from the past which you have continued.

Worse, the trend seems even more irresponsible; where will it stop? When will we stop dismembering, bludgeoning the DOE? When will we arrive at a steady, stable energy program?

Secretary Herrington. The Administration has consistently called for less spending, less taxes and less regulation. It has consistently applied this policy to the Department of Energy. Oil decontrol worked; we are calling for natural gas decontrol because it will, we suspect, work well, also. With respect to spending, we believe the government has a valid role to play in supporting basic research; we are skeptical about applied research and have consistently opposed massive subsidies in this area. Policy must also reflect fiscal realities and that causes us to be somewhat tighter in our proposals this year. Like yourself, we, too, would like to see a "steady state", but we would like to see it at a lower spending level than we have had in the past.

DEFERRALS

Mr. Fazio. I understand you have agreed to reclassify some of the deferrals as rescissions, so they are subject to the 45 day Congressional approval requirement. Which are those?

Secretary Herrington. The Department plans to reclassify six Energy Research Univerity construction projects from deferrals to rescissions. The projects are the Center for Science and Technology at Atlanta University; Advanced Science Center at University of Oregon; National Center for Chemical Research at Columbia University; Demonstration Center for Information Technologies at Brown University; Energy and Mineral Research Center at the University of Alabama; Center for Energy and Biomedial Technology at Tulane University.

Mr. Fazio. Will the Department be sending more deferral requests up in 1986.

Secretary Herrington. No deferrals other than those proposed with the FY 1987 Budget are anticipated.

DEFERRALS

Mr. Fazio. Please provide us with a list of all the non-federal partners with which the Department of Energy has contracts in each of the deferred programs together with case by case assurance that these contracts can and will wait for the eventual obligation of the deferred funds so that the program will continue as Congress intended.

Secretary Herrington. We did not consult with the contractors in the development of the Administration's FY 1987 program plans or the methods of financing so I am unable to provide you with the case-by-case assurances you are seeking. We have already agreed to reclassify six university facility projects from deferrals to rescissions. These projects were with the Universities of Alabama, Atlanta, Oregon, Tulane, Brown and Columbia. No funding has been requested in FY 1987 to continue these projects. Under our proposal support for the other individual contractors will be terminated on March 20. As you are aware, the Federal Procurement Regulations instructs that a contractor must not perform work in anticipation of funding. Work performed prior to receiving contractual authority is not billable under these regulations. As you are also aware, the Budget Impoundment and Control Act of 1974 provides a mechanism whereby the Administration can propose a change in Congressionally approved funding. In so doing, Congress also has the opportunity to consider changed circumstances, revised priorities and plans, and then accept or reject the proposal. We hope the committee will avail itself of this opportunity to work with us to address the high priority that Congress, as well as the Administration, has placed upon controlling the Federal deficit.

DEFERRAL

Mr. Fazio. Will you stipulate that in instances where the DOE does not have such specific assurance the deferral could cause the program's death, and should therefore be treated as a rescission?

Secretary Herrington. The President's deferral proposal as submitted does not call for elimination of the availaility of these monies but in fact proposes that these funds be used in FY 1987 for higher priority projects. This proposal in no way precludes the Congress from exercising its prerogatives to overturn the deferral through legislation. The Department does not intend to change these deferrals to rescissions because it would undermine the financial structure of the President's FY 1987 budget proposal.

DEFERRAL

Mr. Fazio. Will you voluntarily reclassify each deferral for which assurances are lacking as a rescission? In cases where contractors assure you they are not going to wait, will you at least reclassify those as rescissions?

Secretary Herrington. We have reclassified several of our originally proposed deferrals into rescissions. However, to assure our ability to finance high priority activities in FY 1987, it remains essential that a portion of FY 1987 funds continue to come from previous appropriations deferred from less essential activities.

DEFERRAL

Mr. Fazio. When the Congress and the Administration arrive at agreement on an appropriations bill, what good faith obligation do you consider youself under to implement all the provisions in the bill, the one others support as well as the ones you request?

Secretary Herrington. The Department is obligated to, and does, carry out all the provisions in Appropriation Acts. When a departure is anticipated, or occurs unanticipated, the Department attempts to meet all the provisions of law as set forth in the Budget Impoundment and Control Act of 1974. The Department also attempts to follow the additional committee guidance provided in the form of the various reports. When we find we are unable to comply with this guidance, we have always attempted to resolve these conflicts with the Committees through the reprogramming procedures which have evolved over time.

PROCUREMENT OF EHV EQUIPMENT

Mr. Conte. Mr. Secretary, welcome back before the Committee. It is a pleasure to see you. During last year's hearings, we discussed the current difficulties of the Extra High Voltage (EHV) electrical equipment manufacturing industry. You indicated at that time that you would "make every effort to accommodate American industry, to help them be as competitive as possible" on DOE-related projects. Under the Buy America Act, you have the discretion to alter the Buy America differential, or even to make procurements strictly American, upon a national interest determination. Would you tell us what actions you have taken in the past year to help improve the competitive position of the domestic industry on DOE-related procurements?

Mr. Herrington. Mr. Conte, let me assure you that we have adhered to all of the statutory procurement requirements, including the Buy America Act, in all our DOE-related procurement activity including those of the Power Marketing Administrations. As I explained in a letter to you last spring, I am sympathetic to the concern that you have raised. Per your request, I explored the possibility of increasing the Buy America Act differential for the BPA procurement of direct current intertie uprate equipment, a procurement which was a joint effort with non-Federal utilities in California. As you

also know, I had to conclude that the procurement was not considered an appropriate action to address the larger policy questions you have raised. However, it should be noted that all three firms who responded certified that the product they were offering was a domestic end product under the provisions of the Buy America Act.

During FY 1986, the Western Area Power Administration (Western) plans to award a contract for procurement of Extra High Voltage power equipment totaling about $9 million. Western will add a 25-percent differential factor to bids received from foreign manufacturers for purposes of evaluating all bids on a more competitive basis.

I am sympathetic to the pressures faced by domestic EHV vendors when they are confronted by competition from offshore vendors whose prices may have been made especially attractive by the relative strength of the dollar against other currencies in the last several years. I can understand your efforts last year to increase the "Buy America" cost differential during FY 1986 to 25 percent.

The Administration objected to this statutory approach because history has shown that the passage of such legislation would do more harm than good to the American economy. This is still the Administration's position. Recently Commerce Secretary Baldridge communicated this position in testimony before the Congress. The Administration's approach to help improve the competitive position of domestic industry has been to actively cooperate with the other Group of Five Countries to reduce the price of the dollar relatie to the currency of the foreign countries most actively participating in our EHV

market. Since I last appeared before this Committee, the price of the dollar has fallen 39 percent against the Japanese yen; 38 percent against the Swiss franc, and 22 percent against the Swedish krona.

The Administration is very encouraged by this development and is hopeful that this enhancement to the competitive position of the domestic EHV industry will obviate the need for continuation of special one year consideration provided the domestic EHV industry in the FY 1986 Energy and Water Development Act.

Mr. Conte. As you know, Section 506 of Public Law 99-141 provided for a 25-percent Buy America differential for EHV procurements. What action did the Department take to implement that provision? Please identify for the record and provide the Committee a copy of any memoranda or instructions provided by the Department for the implementation of this provision.

Mr. Herrington. Mr. Conte, I am advised that the Department has forwarded a copy of Public Law 99-141 to the power marketing administrtions. Since provisions of the Act can be carried out using existing formal acquisition regulations, there was no need for formal specific instructions following enactment of the public law.

Mr. Conte. Why did the Department choose not to provide guidance to the Power Marketing Administrations in implementing Section 506 of Public Law 99-141? Why were the PMAs not instructed on how to comply with that provision?

Mr. Herrington. I am advised that the power marketing administrations are cognizant of the one-year provision. Since provisions of the Act can be carried out using existing Federal Acquisition Regulations, there was no need for formal specific instructions following enactment of the public law. Existing procurement regulations require compliance with all applicable Federal statutory provisions.

ELECTRICITY SUPPLY

Mr. Conte. With so many utility managements saying that they are going to try to avoid building major generating stations, what can DOE do to avoid pockets of electricity supply deficiencies?

Secretary Herrington. The Department believes that deficiencies of economic generating supply can best be avoided by making state regulators and the general public aware of the need for new electric power supply and by fostering conditions that encourage needed power supply to be built. Such conditions would include rate regulation that allows utilities

to earn a market rate of return on investments, less burdensome environmental and zoning regulations, and streamlined licensing of new power plants and transmission lines. In general, the risks and rewards for electricity suppliers need to be brought into better balance if economic supply is to be forthcoming.

TRANSMISSION GRID

Mr. Conte. What is your view of building a national grid to ship bulk power anywhere in the country? In light of the utilities' reluctance to undertake such major projects, is there any alternative to a federal building program? Does the national interest in such a grid justify such a program?

Secretary Herrington. The recent growth in bulk power markets has led to reconsideration of the purpose for electricity transmission grids. Originally designed for reliability purposes, these systems are now being viewed as a potential means of increasing efficiency in bulk power markets. The transmission of surplus and relatively inexpensive electricity from one area to another could delay the need for construction of additional capacity. Thus, it may make economic sense to upgrade transmission systems and interconnections in some areas.

However, if additional transmission capacity provides power at a lower cost than alternative sources, investors will have incentives to upgrade that system. The Federal government can best help by assuring that regulated transmission service rates are market-based and by working with states to alleviate barriers to constructing additional transmission capacity.

ELECTRIC SUPPLY TECHNOLOGIES

Mr. Coste. Given the current inadequacy of domestic research and development in the electric utility industry, isn't it likely that electric utilities will have to look overseas for innovation and technological advances? Won't this situation be exacerbated by foreign governments' support of exports to this country?

Secretary Herrington. Research and development on new, innovative electricity supply technologies is being carried out all the time, by both the domestic regulated electric utilities and by the electricity supply technology industry. It is possible that some domestic electric utilities will look overseas for new technologies and innovations.

The electricity supply technology industry is highly competitive with strong, innovative companies in (among others) France, the Federal Republic of Germany, Japan, Canada and the United Kingdom. Our electric utilities would certainly be interested in any competitive offering from firms from any of these nations.

Domestic research on innovative and/or advanced electricity supply technologies is substantial. In addition to the mainstream Department of Energy R&D programs, the Clean Coal Technology program is expected to generate a minimum level of effort of $800 million over the next three years. The electric utility industry is also supporting a substantial R&D program (projected at $352 million in 1985) through the Electric Power Research Institute, and private sector companies (both users and equipment suppliers) have their own R&D programs as well. The U.S. has been a world leader in electric supply-related technologies for many years and is expected to continue to be the world leader for the foreseeable future.

It is possible that foreign governments' support of exports to this country would have some effects. However, U.S. firms have successfully competed against such problems for a long time. It is not clear that there is a need for any new Federal action at this time.

Mr. Conte. Given the danger of U.S. industry falling behind in the world market, shouldn't the Department be increasing its very limited R&D efforts in the electrical area?

Secretary Herrington. We would not describe the Department's R&D efforts in the electrical area as "very limited." Domestic research on innovative and/or advanced electrical supply technologies is substantial. In addition to the mainstream Department of Energy R&D programs, the Clean Coal Technology program is expected to generate a minimum level-of-effort of $800 million over the next three years. The electric utility industry is also supporting a substantial R&D program (projected at $353 million in 1985) through the Electric Power Research Institute, and private sector companies have their own R&D programs as well.

In any event, the effect of Federal R&D on the nation's ability to compete is small compared to other economic variables. In a recent study, Wharton Econometric Forecasting Associates constructed an index to measure how ready or prepared the United States is to compete with foreign nations. Trading-partner countries included in this study were Japan, Canada, West Germany, the United Kingdom, France and Italy. This "Trade Performance Index" is a good predictor of U.S. trade performance (with an average lag of one-and-one-half years).

Wharton's analysis showed that the single biggest factor explaining changes in the Index is the relative-unit-labor-cost term. An increase in the ratio of foreign to U.S. R&D expenditures as a percent of GNP produces a decrease in the Index, signifying a decreased U.S. ability to compete, but this has the smallest effect of any of the several variables considered.

Factors included in the analysis were:

- o relative unit labor cost;
- o the presence of fixed exchange rate regimes;
- o the ratio of foreign to U.S. R&D expenditures as a percentage of GNP;
- o relative real interest rates; and
- o the U.S. personal savings rate.

ELECTRICITY R&D FUNDING

Mr. Conte. What is your position on whether the Federal Government should allot R&D funds to the Electrical Power Research Institute (EPRI)?

Secretary Herrington. The research and development programs conducted by the Department are generally complementary to the efforts by EPRI.

In general, DOE's R&D programs emphasize long-term, high-risk efforts which support a mix of technologies aimed at improving our understanding of the fundamentals of matter, expanding domestic energy supplies, and achieving greater efficiency in energy use. In addition to specific energy technology programs, DOE conducts research in basic energy sciences and on the health and environmental phenomena associated with energy technologies.

EPRI's R&D strategy focuses primarily on the short- and mid-term (the next 5 - 15 years) and has 4 major components:

- o Enhance reliability, efficiency and productivity -- including resolution of nuclear safety issues and work on an Advanced Light Water Reactor (LWR);

- o Develop viable conservation and demand management technologies;

- o Respond to environment and health issues; and

- o Develop and demonstrate advanced technologies that meet resource, economic and environmental guidelines.

In certain special cases, EPRI and DOE are involved in cooperative efforts on the same program. For example, DOE and EPRI have signed an MOU providing for cooperation in development of Advanced Light Water Reactors for the early 1990's. In such limited cases, some DOE funding to EPRI is appropriate. However, in these cases, the fraction or total program funding allotted to EPRI would be small.

ANTITRUST LIABILITY

Mr. Conte. What is your position on whether manufacturers in all areas of energy R&D should be permitted to cooperate without antitrust liability?

Mr. Herrington. There is a law that covers cooperation of manufacturers in R&D. In October 1984, the President signed the National Cooperative Research Act of 1984, which is intended to promote research and development and encourage innovation. The Department of Energy urged the President to sign this law. Under this law, companies can join together to conduct precompetitive R&D. This type of joint venture conduct still falls within the antitrust laws; however, the courts must follow a rule of reason approach and not a per se approach in judging the activities of the joint venture. The rule of reason approach is a less stringent standard by which the courts will judge whether the firms' conduct within the joint venture is anticompetitive. The law also provides that any companies found to have violated the antitrust laws will be liable for single damages and not the treble damages normally applied under the antitrust laws. Any companies wishing to take advantage of the protections of this law must file their joint venture agreement with the Department of Justice and the Federal Trade Commission. Those agencies will notify the public as well as review the joint venture agreement to determine if any problems arise from the joint venture agreements. Once the statutory requirements are met, the law's protections become effective. Therefore, Mr. Conte, since present law covers cooperative research, companies can afford themselves of the protections of the antitrust laws and can undertake joint research confident that they will not be exposed to undue antitrust liability.

URANIUM ENRICHMENT

Mr. Conte. The proposed schedule for uranium enrichment payback would appear to force the United States out of the enrichment business entirely. Would you comment on that possibility, and indicate whether the budget contains a realistic payback plan?

Mr. Herrington. The Department has established a plan to pay the Treasury for existing unrecovered uranium enrichment costs. There are 4 guiding principles used in developing the plan.

First, the outstanding Government investment should be recovered in a manner that does not damage the Nation's uranium enrichment capability.

Second, the uranium enrichment services and pricing structure should be competitive.

Third, the recovery plan recognizes both the competitive nature of the international uranium enrichment market and the compelling national mandate for reduction of the Federal deficit.

Finally, the recovery plan recognizes the need for institutional restructuring of the Nation's uranium enrichment services, to include private sector involvement. Initial efforts will focus on transferring to the private sector responsibility for Atomic Vapor Laser Isotope Separation research, demonstration, and deployment. It is currently envisioned that all new enrichment capacity will be financed totally by the private sector.

The amount of annual repayments have been set at $110 million in FY 1986 and $235 million in FY 1987. The amounts in later years are

targets only at this time. The actual amounts will be set in the annual budget process after full consideration is given to the guiding principles. The FY 1986 and FY 1987 payment amounts will be maintained while at the same time supporting price reductions in both fiscal years. We project further price reductions over the next few years until our price reaches competitive levels. Therefore, the Department believes that our guiding principles, including transfer of AVLIS to the private sector, are sound and that our repayment plan will not force the United States out of the enrichment business.

NUGLEAR RESEARCH OPTIONS

Mr. Conte. How does the Department plan to keep the various nuclear research options open in light of the proposed cutbacks in civilian nuclear R&D?

Mr. Herrington. The FY 1987 Advanced Reactor research and development program remains directed towards conducting, in concert with industry, the national laboratories, and universities, the R&D leading to an economic advanced reactor system for potential use by the commercial sector.

The program's success depends on resolving several key technical and regulatory issues. A key objective will be to achieve the level of inherent characteristics necessary to provide a passive shutdown of a reactor system and remove its decay heat without operator action and without reliance on complex "engineered" safety systems. Also, interactions with NRC must verify that the new design and licensing approaches are feasible. Finally, additional economic analysis must be conducted to verify that perceived cost improvements are obtainable. Economic advanced reactor concepts cannot be designed or developed without these basic understandings in hand. The proposed FY 1987 budget does not preclude developing this information on a timely basis.

In addition, the Department will review the current system of assessing users fees with the goal of developing appropriate, alternate approaches. This should help ensure continued support from our laboratory facilities for all of our programs.

It is also important to note that use of the technical expertise at our contractors is one of the areas common to both our civilian and defense related reactor system development programs. This provides some additional flexibility to preserve requisite expertise in the face of fiscal constraint.

LIGHT WATER REACTORS

Mr. Conte. What do you consider to be the appropriate role for DOE in revitalizing the light water reactor program or pursuing advanced reactor concepts?

Mr. Herrington. The Department continues to support government and industry efforts to improve the viability of the nuclear power option by removing unnecessary financial and institutional obstacles to future deployment of nuclear reactors and continuing to improve safety, reliability, and technolgy. A substantial portion of the R&D on light water reactors is devoted to cost-shared programs with industry to pave the way for introduction of advanced, more standardized, light water reactors. Such plant designs, certified by the Nuclear Regulatory Commission and reviewed by rate commissioners and the utility industry in advance of a decision by the utility to construct new generating capacity, can provide a firm foundation for cost-effective and highly reliable nuclear power for the future.

This technical foundation can help to remove questions about economic performance and safety. However, introduction of latest available technology is no substitute for institutional reform. We continue to urge enactment of H.R. 2488, the Administration's nuclear licensing and regulatory reform proposal introduced on May 14, 1985. This is consistent with policies most recently articulated in the President's transmittal of his State of the Union address. Moreover, the Department has and will continue to speak out on the issues that face the nuclear power industry,

such as the July 25, 1985, testimony of Deputy Secretary Danny Boggs before the Senate Committee on Energy and Natural Resources. This support for action on the institutional front includes utilization of our available resources and a firm commitment on work with groups such as the Atomic Industrial Forum on key regulatory issues, the Institute for Nuclear Power Operations on key utility operational issues, and other Federal agencies on export opportunities.

NATIONAL LABORATORIES

Mr. Conte. How do you plan to keep the national laboratories as strong national resources and assets in light of the severe budget cuts affecting the laboratories?

Mr. Herrington. The Department fully realizes the importance of its laboratories to the national scientific effort. Some personnal adjustments may be necessary in FY 1986, but current indications are that they will not significantly impact the capabilities of the laboratories in the present year. Moreover, the multiprogram laboratories are and will continue to be strong national resources in light of the President's FY 1987 budget. Three of the laboratories, which focus primarily on national security missions, will show some significant budget growth. The national laboratories focusing on energy research will experience some reductions in the applied energy areas, but given the emphasis on basic research in these laboratories, their overall budget generally fare well in FY 1987. In fact, we have requested support for initiatives involving four new scientific facilities to maintain the scientific excellence of the laboratories in the future. We also will continue to provide important institutional support for general purpose facilities.

Statement of John S. Herrington
Secretary
Department of Energy
FY 1987 Appropriations Hearings

Mr. Chairman and Members of the Committee, I appreciate the opportunity to present the FY 1987 budget for the Department of Energy. This budget supports the major themes of this Administration and is fully responsive to the requirements of the historic Gramm-Rudman-Hollings Balanced Budget and Emergency Deficit Control Act. It is a lean, trim, and sharply focused budget, which provides adequate funds for essential activities in the Department's three primary mission areas of Energy, General Science, and Defense. Before discussing details of the budget itself, I would like to describe the current energy situation and the Department's policy and budget initiatives.

CURRENT ENERGY SITUATION

Energy problems are no longer a destabilizing force in the national life and economy. The attempts by the OPEC cartel to limit production and control prices have failed. Real crude oil prices are down some 40 percent since early 1981, and are projected to decline further. The Nation is using its energy supplies more efficiently than ever before. Total U.S. energy production for the past two years has been at record high levels, and net oil imports are one-third less than they were in 1980.

This greatly reduced level of imports, the excess oil production capacity worldwide, and the almost 500 million barrels of crude oil in our Strategic Petroleum Reserve, serve to reduce substantially the likelihood of a major supply disruption.

Nevertheless, despite the favorable current situation we must not become complacent. We must use this respite to plan for a strong, secure energy future in an atmosphere of calm resolve.

POLICY AND BUDGET INITIATIVES

The Administration's overall energy goal is an adequate supply of energy at a reasonable cost. We can achieve that goal through the combination of energy stability, energy security, and energy strength. Energy stability has been achieved over the past five years. Our energy security is growing stronger day by day. Our objective for the immediate future is to build this Nation's energy strength, making full use of its vast natural resources and the daring and ingenuity of its citizens. Our approach includes removing technological and institutional barriers to increased use of coal and nuclear power, opening the Outer Continental Shelf to responsible hydrocarbon production, and eliminating the remaining price controls on natural gas. At the same time, we will continue to support advances in conservation as well as possible energy sources of the future such as magnetic fusion.

Some of these initiatives require budgetary resources, but many do not. The President's decontrol of oil in January 1981, required only the stroke of a pen, yet nothing has done more to put this Nation back on the right energy track. Reforming the nuclear licensing process and permitting all gas to sell at market rates would have a negligible budgetary impact, but would have immense, long-lasting benefits. Federal funding for appropriate activities can help us to reach our energy goal, but Federal funds are in short supply.

deficit reduction is perhaps the preeminent domestic economic imperative today, and the Department fully recognizes that fact. For this reason, we are doing all we can to concentrate increasingly scarce resources on those programs and projects that directly fulfill a responsibility of the Federal government and truly require Federal assistance. If we are to achieve our overriding goal of deficit reduction we cannot afford to continue to allocate scarce Federal resources to activities where the rationale for continued Federal involvement is weak, and where State and local organizations or private industry can and should take over responsibilities presently borne by the Federal government. Also, we cannot permit programs or projects to continue with Federal support unless they meet a high priority national need.

These policies are evident in the FY 1987 budget for the Department of Energy. Among the major initiatives are the privatization of the Federal interest in Naval Petroleum Reserves No. 1 and No. 3 and the deFederalization of the Power Marketing Administrations. There is no national security reason for the government to continue to run the Naval Petroleum Reserves today, almost seventy five years after they were established. They have not been true reserves since 1976, when Congress determined that the Reserves should be produced at their maximum efficient rate and the output sold.

Similarly, the Power Marketing Administrations principally perform electric utility functions which are not fundamentally Federal in nature. We believe non-Federal entities could perform the same services with equal or greater efficiency and be subject to local and regional control, as is true for most of the electric power now sold in the Nation.

Another new initiative in the FY 1987 budget involves cooperative research and development ventures with private industry consortia. Our Fossil Energy organization will conduct a pilot program in FY 1987 and the Conservation and Solar Technology areas will investigate similar venture partnerships with industry. The use of cooperative research and development ventures should serve to concentrate resources on research and development activities that more broadly support industry, promoting more effective technology transfer and providing better leveraging of scarce federal resources.

Our rigorous attempt to limit federal support in FY 1987 to only the highest priority projects and programs whose success will serve the national interest has implications for FY 1988 as well. This policy has resulted in our withdrawing support from a number of activities deemed to have lower priority, deferring the funds thus saved, and using them to reduce the need for new budget authority for more worthy activities in FY 1987. We have no choice under the current and necessarily strict fiscal regimen but to concentrate scarce resources where they show promise of bringing the greatest benefits.

The budget proposes an indefinite moratorium on further development of the Strategic Petroleum Reserve (SPR) and a cessation of fill later this year when 500 million barrels of crude oil will be in storage. The SPR represents a wholly adequate "insurance policy" given the current energy situation, and, in fact, achieves the level of protection envisioned by Congress when it established the program. The moratorium will be reassessed as economic conditions and the world oil market conditions change.

The Environment, Safety and Health functions have been centralized and expanded, with greatly increased funding for oversight and planning activities under the direction of the new Assistant Secretary. This underscores the Department's commitment to give high priority to public and worker health and safety in our operations. Similarly, the Department will direct increased funding to another area of priority concern, which is upgrading safeguards and security at the Department's facilities.

With this as introduction, let me turn now to the major elements of the Department's FY 1987 budget.

Budget Overview

The FY 1987 budget for the Department of Energy is $12.1 billion, which is $400 million below last year's request and about one percent above the FY 1986 funding levels as reduced by the President's Sequester Order pursuant to the deficit reduction legislation. Outlays are anticipated to be approximately $12.5 billion. Within the $12.1 billion request the Department has sought to maintain the priorities and budget strategies which have characterized the Department's budgets since the advent of this Administration. These include a concentration on longer-term research and development leading to a balanced and mixed energy resource base, and a withdrawal from continued efforts in more mature technologies, where responsibility for further development should rest with the technology's private sector sponsors.

As mentioned above, legislation is being proposed to permit the transfer of Federal control over the Naval Petroleum Reserves No. 1 and No. 3 and the Power Marketing Administrations. However, pending Congressional approval of these proposals, full funding for these organizations in FY 1987 is included in the budget. Other legislative initiatives associated with this budget would modify the Federal investment repayment practices of the Power Marketing Administrations, without changing interest rates on past investments.

The Department's budget is presented in six categories. Each category groups activities which share common characteristics. The FY 1987 budget for Research and Development is about 7 percent below the FY 1986 level when amounts of new budget authority are compared. However, the level of actual program activity is higher, as FY 1987 will benefit from large sums of unobligated budget authority carried over from FY 1986 and made available for program use. Most of these unobligated balances will result from savings due to cost reductions in the Uranium Enrichment program, primarily the termination of the Gas Centrifuge Enrichment Plant.

Comparing funding levels within the Research and Development category at the level of actual program activity, increases in high energy and nuclear physics, environmental activities, supporting research, weapons research and development, and Naval reactors more than offset reductions to fossil, conservation, solar, nuclear energy and magnetic fusion programs.

Defense Production and Support, $4.8 billion, increases by $498 million from FY 1986, due to increased requirements from the Department of Defense for weapons systems, and for special nuclear materials for use in weapon systems and by the nuclear Navy.

The budget request for Waste Activities, $1.8 billion, is 30 percent greater in FY 1987 than FY 1986, with increases in all major program elements; the Nuclear Waste Fund, Remedial Action and Waste Technology, and Defense Waste Management.

The budget request for Business Enterprises is $691 million. Funding requirements for Business Enterprises are about 20 percent lower than in FY 1986. In addition to the uranium enrichment enterprise and the Strategic Petroleum Reserve, this category includes the Naval Petroleum Reserves and the Power Marketing Administrations, which the Administration will actively seek to transfer to non-Federal control. However, the budget includes full funding for these activities through FY 1987 to assure continuity of operations.

The Grants and Other Energy Functions category has a budget request well below the FY 1986 level, due primarily to the withdrawal of direct appropriations for State energy conservation grant programs. These programs will be able to rely on large sums made available to the States in restitution for petroleum pricing and allocation violations.

Departmental Management, which includes management and support functions in Washington and the field, is almost unchanged from FY 1986.

I would now like to discuss the budgets for selected program areas.

GENERAL SCIENCE

The budget request for the General Science appropriation in FY 1987 is $773 million, an increase of almost 18 percent over last year. The General Science account includes the High Energy Physics and Nuclear Physics programs, which are a major part of the National effort to identify the basic constituents of matter and the basic forces in nature.

A major feature of the High Energy Physics program in FY 1987 will be the first research operation of two major colliding beam facilities--the Tevatron proton-antiproton facility at Fermilab and the Stanford Linear Collider, an electron-positron collider, at the Stanford Linear Accelerator Center.

The highest priority for new construction in basic nuclear research is the Continuous Electron Beam Accelerator Facility at Newport News, Virginia. Construction will be initiated in FY 1987 for this unique, world-class facility.

The FY 1987 program also provides funding for research and development on superconducting magnets and systems related to the next generation particle collider. The results of prior research and development in this area will provide the technical information for Departmental review of a Superconducting Super Collider-type facility.

ENVIRONMENT

I have continued to stress the importance of environmental concerns at the Department, and the FY 1987 budget request reflects this theme. The funds requested for environmental compliance activities throughout each of the Department's program areas as well as for the Environment, Safety and Health program area have increased this year. The Department's programs are formulated in a manner that balances research and development and production requirements with the need to protect the environment. Funding for the Environment, Safety and Health program, which increases by almost 95 percent over the FY 1986 level, will support the key elements of the Department's long-range plan which provides for a strong emphasis on environmental and safety matters at DOE facilities.

The Department is conducting a baseline survey of all facilities to identify existing areas of environmental risk. Results from the survey will be used to prioritize areas requiring corrective action. We are committed to developing standards for environmentally sound operations at all DOE facilities.

OTHER ENERGY RESEARCH

This category includes Magnetic Fusion, Biological and Environmental Research, and Basic Energy Sciences.

The Magnetic Fusion budget of $333.0 million in FY 1987 is about 9 percent below FY 1986. Our focus this year will be on the development of the toroidal magnetic confinement system. The program has been structured to maintain the highest priority tasks, improve the cost effectiveness of facility operations, and increase the use of international collaboration. We have always stressed international collaboration in fusion research, and will be emphasizing this even more in light of the agreements reached at the Geneva Summit.

We are proposing a budget of $197 million for Biological and Environmental Research in FY 1987, which is an increase of 9 percent over FY 1986. This program represents the Nation's only long-term research effort specifically focused on energy-related health and environmental issues. The FY 1987 program will continue its focus on understanding the long-term health and environmental effects of radiation and energy-related chemicals. This program also performs research on such issues as acid rain and the so-called "Greenhouse effect."

The mission of the Basic Energy Sciences (BES) program is to perform generic, long-range, energy-related research in both nuclear and non-nuclear fields. The FY 1987 budget request of $441 million is slightly above last year's effort. In conducting this program, we support energy-related research and operate research facilities in the physical and biological sciences, engineering, applied mathematics, and geosciences. In FY 1987 funds will continue the construction of the Center for Advanced Materials at the Lawrence Berkeley Laboratory, and support upgrades of the National Synchrotron Light Source at the Brookhaven National Laboratory and the Synchrotron Radiation Laboratory at the Stanford Linear Accelerator Center.

FOSSIL ENERGY

The Fossil Energy program is directed at establishing the scientific and engineering foundation to support private sector efforts to develop and deploy fossil fuel technologies. The budget request of $150 million concentrates adequate resources on high priority activities in coal, petroleum and gas technologies. Clean use of coal is the principal focus of our fossil program, and we will continue work in liquefaction, gasification, combustion systems, fuel cells, heat engines, and techniques for the direct combustion of coal in an environmentally sound manner.

The budget request is divided into three functional elements: Technology base development funds will provide direct support for basic, fundamental and crosscutting research through contracts and research grants directed principally to national laboratories, Energy Technology Centers, and universities. Applied research and development activities will be funded with industry using various

contractual instruments. Finally, a cooperative research and development venture pool of $12.5 million will be established to fund applied research and development joint ventures with industry consortia. It is expected that the Department would take minority positions in these ventures, which would leverage scarce Federal resources and provide for more active technology transfer.

In addition to activities supported by the budget request, the Department will begin a 3 year Clean Coal Technology program this year, utilizing $397.6 million of previously appropriated funds. A solicitation for competitive proposals was issued on February 17, 1986. Projects will be cost-shared up to 50 percent by the Federal government, and will be selected by August 1, 1986.

RENEWABLE ENERGY

The focus of the Solar and Other Renewable Energy program in FY 1987 is on supporting research and development that will strengthen the technology base on which industry can draw in developing future new products and processes for the commercial market. The program supports activities ranging from basic research in universities and national laboratories to applied research and development and proof-of-concept projects in industrial firms.

Our budget request of $92 million continues program activities in each major solar and renewable technology area, but at levels below FY 1986. Reductions proposed in the 1987 budget will limit support to only the highest priority activities. We are also pursuing a new funding approach for applied, but pre-competitive, technology development involving partnerships with industry. Cooperative research and development ventures will be investigated, and

expressions of interest will be solicited from industry. We believe that the use of cooperative research and development ventures will be an effective method of leveraging limited Federal resources, and has the additional advantage of promoting more effective technology transfer to the private sector.

CONSERVATION

The Department views conservation as an energy resource and its practice has made important contributions to the Nation's improved energy posture. The emphasis of the Energy Conservation Research and Development program is to assist the private sector by conducting research targeted at expanding the technology base upon which industry can draw in developing new products and processes for the marketplace. Although the FY 1987 budget request of $71 million is substantially less than this year's level, we believe that we are directing adequate funding to the highest priority activities.

We will continue efforts in all of our current research and development areas such as buildings and community systems, industrial and transportation conservation, and advanced concepts in energy conversion and utilization. In addition, the new cooperative research and development approach will be explored and expressions of interest will be solicited from the private sector regarding their participation.

The budget request proposes no further Federal support for the Conservation Grants programs, except for a small amount in FY 1987 to fund the orderly close-out of Federal responsibilities. We believe that the States should assume responsibility for these activities. They will be able to make use of very

large sums specifically designated for conservation and other energy-related activities which will be made available to them in restitution for oil pricing and allocation violations. Continued use of appropriated Federal funds for these programs is, therefore, no longer necessary.

NUCLEAR ENERGY

The emphasis of the Department's Nuclear Energy programs in FY 1987 is being shifted to ensure that nuclear energy contributes to civilian needs for a balanced and secure domestic energy base as well as emerging military needs to meet national security objectives. The budget request of $333 million, is slightly below the FY 1986 level. However, we have structured a program to coincide with the anticipated timing for commercial deployment of advanced reactors beyond the light water reactor, and which also meets increasing space and defense nuclear energy requirements. This essential program fits within the limited resources available during times of budgetary constraints.

The Light Water Reactor program will continue with emphasis on supporting a process leading to enhanced safety, rationalized licensing, and certification of advanced designs. These cost-shared activities are closely coordinated with industry and complement industry's own efforts.

The primary emphasis in advanced reactor research and development is to support national security requirements, including the Strategic Defense Initiative. We expect that benefits will accrue from this research and development that can be applied to future commercial reactor development efforts.

DEFENSE ACTIVITIES

The Department's FY 1987 budget request for Atomic Energy Defense Activities is $8.2 billion. The request meets the requirements of the Department of Defense for weapons production and deliveries. It also includes research on new and improved weapons, testing, production of special nuclear materials, and Naval reactors development.

Weapons research, development, and testing is a large portion of the defense programs budget at $2.1 billion. This includes weapons design, advanced weapon technology, support for the Strategic Defense Initiative, the testing of new weapons, and monitoring and testing of the nuclear weapons stockpile to assure continued reliability and effectiveness.

Weapons production and the production of special nuclear materials are funded at $2.5 billion and $2.0 billion, respectively. The Department's defense production activities respond to the requirements of the Defense Department and the need to modernize the Nation's defense force structure. In FY 1987 we will have eight weapons in production and pre-production efforts will be conducted on another 11 systems.

Within the Atomic Energy Defense appropriation, we also fund the Naval Reactors Development program which designs, develops, tests, and ultimately disposes of naval nuclear propulsion reactor components and cores. The FY 1987 budget is $594 million, up from $536 million in FY 1986. This increase is due primarily to increased research and development on an Advanced Fleet Reactor and for increased servicing requirements for the eight land-based prototype reactors.

WASTE ACTIVITIES

The safe management and disposal of civilian and defense nuclear waste and cleanup of contaminated facilities have long been prominent elements of the Department's nuclear and defense programs. These programs involve various types of high and low-level waste originating from civilian and defense sources. The budget request for each of these programs has increased in FY 1987.

The Nuclear Waste Fund activities are budgeted at $769 million, a significant increase over FY 1986's $499 million. These funds are directed toward disposal of spent nuclear fuel and high-level radioactive waste in mined, geologic repositories, and the study of monitored retrievable storage.

The Fund is financed by fees collected from owners and generators of spent fuel high-level waste. The increased FY 1987 request will provide for extensive site characterization, continued exploratory shaft design and construction, and intensive engineering tests and analyses required for the first repository. The program is progressing toward initial operation in 1998. The FY 1987 budget also provides support for the continuation of preliminary field investigations and design for a possible second repository. Twelve potentially acceptable second repository sites were proposed in January.

The Department also has two other program areas in which radioactive wastes are treated, stored, or prepared for ultimate disposal. The Defense Waste Management program provides for the interim storage of radioactive wastes generated throughout the DOE-complex during the production of special nuclear materials used in the defense production facilities. A highlight of this

program in FY 1987 is the continued construction of the Defense Waste Processing Facility at the Savannah River Plant, and the Waste Isolation Pilot Plant at Carlsbad, New Mexico. The Remedial Action program objective is to treat or stabilize radioactive waste and clean up contaminated DOE and certain non-government facilities and sites. The Budget in FY 1987 is $790 million, an increase of 28 percent over FY 1986. This increase will maintain the schedule for cleaning up high priority sites throughout the country.

STRATEGIC PETROLEUM RESERVE

The Department intends to continue filling the Strategic Petroleum Reserve (SPR) in FY 1986 until the inventory reaches a level of 500 million barrels, in compliance with current law. No additional oil purchases are planned for FY 1987. Given the current world energy environment, the SPR inventory is more than adequate for use in the event of a supply disruption. In light of this decision, continued creation of storage capacity is unnecessary at this time. Therefore, we are planning to curtail certain development activities during FY 1986 to reduce near-term federal spending for facilities which are not presently required. Funding for these activities is being deferred and proposed for use in FY 1987 for standby operations and maintenance. As a result, no new appropriations are requested. This moratorium on development and suspension of fill of the SPR will be reassessed as economic and oil market conditions change.

URANIUM ENRICHMENT

The budget request for uranium enrichment is $1.3 billion, down slightly from FY 1986, and is offset by revenues of the same amount. During the last year, we

have taken strong actions to revitalize this country's uranium enrichment business. We have streamlined the program, reduced costs, and reduced prices to customers, thus demonstrating our ability to compete in the world market. Through several creative marketing initiatives, the U.S. share of the free world enrichment market increased from 40 percent in 1990 to an estimated 53 percent in 1995. This will result in additional revenues of over $500 million during 1997 - 2002. We are confident that we can get our prices into the world competitive range using the existing gaseous diffusion capacity.

To ensure more efficient commercial deployment of advanced enrichment technology, the Department intends to transfer the development and ultimate deployment of the Advanced Vapor Laser Isotope Separation (AVLIS) process to the private sector.

In FY 1997, we are also proposing to begin repayment of the unrecovered federal investment in the uranium enrichment program. The total federal investment to be repaid is $3.3 billion. In FY 1997, $250 million in revenue collections will be returned to the Treasury.

NAVAL PETROLEUM AND OIL SHALE RESERVES

A major initiative will be undertaken to privatize the Naval Petroleum Reserves in FY 1997. Legislation authorizing the sale of the federal interest in Reserves No. 1 (Elk Hills) and No. 3 (Teapot Dome) will be submitted this fiscal year with the intent of conducting the sale as promptly as possible, probably in FY 1997. The government's role, which has changed from maintaining the Reserves for national security reasons to producing them at their maximum efficient rates

and selling their output competitively, is better fulfilled by private industry. In the interim, the Department will continue to develop, operate and produce the Reserves until the sales are completed. The amount requested for FY 1987 will fund the Naval Petroleum and Oil Shale Reserves for the entire year. Once the sales take place, a rescission of any remaining budget authority will be proposed.

POWER MARKETING ADMINISTRATIONS

There are two major initiatives affecting the Power Marketing Administrations in FY 1987: defederalization and modification of repayment practices.

We will pursue defederalization through an open and competitive process. The goal will be to seek a fair return to the federal taxpayers from the defederalization of these assets, while recognizing the benefits currently enjoyed by existing customers, and recognizing and providing appropriate protections for the personnel benefits of federal employees. Before implementation of this proposal, the views of concerned groups and individuals, including appropriate Congressional Committees, State and local officials, current customers, the financial community, and public power and private sector energy interests will be considered.

Funds are included in the budget for operating the power marketing administrations in 1987, but we will actively seek to defederalize these utility systems. We expect that all five PMAs will be transferred from federal control by 1991. In the interim, the Department is proposing to modify the PMA capital investment repayment process legislatively to protect the interest of the taxpayers. These

modifications require repayment of the unpaid balance of the original federal investment at a level not less than would be required under a fixed, straight-line amortization schedule for each power investment financed by appropriations and placed in service. The impact of this proposal is relatively modest.

Mr. Chairman, I believe that the budget I have summarized meets the Department's responsibilities in its several mission areas in a manner which recognizes today's fiscal responsibilities and tomorrow's anticipated needs.

U.S. Department of Energy
Assistant Secretary for
Congressional, Intergovernmental
and Public Affairs
Office of Public Affairs
Washington, D.C. 20585
202 252 5644

BIOGRAPHY

JOHN S. HERRINGTON

On January 18, 1985, John S. Herrington was nominated by President Ronald Reagan to be the fifth Secretary of Energy. Mr. Herrington was confirmed by the United States Senate on February 6, 1985, and sworn into office on February 7, 1985.

Prior to joining the Department of Energy, Mr. Herrington served in the White House as Assistant to the President of the United States. Before assuming that post, he served as Special Assistant to the Chief of Staff, the White House, from February to May 1983. Mr. Herrington also served as Assistant Secretary of the Navy from October 1981 to February 1983. He was a member of the Reserve Forces Policy Board, the Military Manpower Task Force Working Group, the Department of Navy Review and Oversight Council, and Chairman of the Defense Department Per Diem Committee. For his service in the Department of Defense, Mr. Herrington was awarded the Distinguished Service Medal, the Department's highest civilian award. Mr. Herrington also served as Deputy Assistant to the President and Director of Presidential Personnel after he moved to Washington in January 1981.

Mr. Herrington was born in Los Angeles, California, May 31, 1939. He graduated from University High School, Los Angeles, California, in 1957. He is a graduate of Stanford University where he received his A.B. degree in economics in 1961. Mr. Herrington received his LL.B. and J.D. degrees at the University of California, Hastings College of Law, San Francisco, California, in 1964. M. . Herrington has been a practicing attorney in California since 1965 specializing in corporation, real estate, taxation, and business law. He also expanded his interests into real estate development, ranching, restoration of historic buildings, and other investment undertakings. Mr. Herrington has also served as a Deputy District Attorney in Ventura County, California, and a First Lieutenant in the United States Marine Corps Reserves.

Mr. Herrington is married to Lois Haight Herrington, Assistant Attorney General of the United States. They have two daughters, Lisa Marie (age 19) attending the University of California at Los Angeles, and Victoria Jean (age 18) attending the University of Southern California. The Herringtons reside in McLean, Virginia.

June 1985

TUESDAY, MARCH 11, 1986.

GENERAL SCIENCE, BASIC ENERGY SCIENCES, AND SUPPORTING TECHNOLOGY

WITNESSES

DR. ALVIN W. TRIVELPIECE, DIRECTOR, OFFICE OF ENERGY RESEARCH
DR. CHARLES DELISI, ASSOCIATE DIRECTOR, OFFICE OF HEALTH AND ENVIRONMENTAL RESEARCH
WILLIAM WALLENMEYER, ACTING ASSOCIATE DIRECTOR, HIGH-ENERGY AND NUCLEAR PHYSICS PROGRAM
DR. DAVID HENDRIE, DIRECTOR, NUCLEAR PHYSICS PROGRAM
DR. DONALD STEVENS, ASSOCIATE DIRECTOR, OFFICE OF BASIC ENERGY SERVICES
TONI JOSEPH, DIRECTOR, UNIVERSITY RESEARCH PROGRAM

Chairman BEVILL. This hearing will come to order.

Dr. Trivelpiece, we are pleased to have you with us. This is the second time this year that you are before us, isn't it?

Dr. TRIVELPIECE. Yes, it is, sir.

Chairman BEVILL. You may proceed as you wish.

OPENING STATEMENT

Dr. TRIVELPIECE. Mr. Chairman, thank you. Obviously, I would like my prepared statement submitted for the record.

Chairman BEVILL. Without objection, it will be so ordered.

[Statement follows at the end of hearing.]

Dr. TRIVELPIECE. First, I would like to introduce some of the people who are with me, particularly in view of the fact that there have been some changes in some of the people who do work for me.

I would first like to introduce Dr. Charles Delisi, on my right. He is the new Associate Director for the Office of Health and Environmental Research. He's a well-published scientist in biology and physics, and comes to us from the National Cancer Institute. He has, previous to that, worked at Los Alamos Laboratory. So he's familiar with the Department's programs as well.

I would also like to introduce Dr. Bill Wallenmeyer, who is the Acting Associate Director for the High-Energy and Nuclear Physics Program; and Dr. Dave Hendrie, who comes to us from the Lawrence Berkeley Laboratory. He has been involved in nuclear physics for many years.

Dr. HENDRIE. It seems like 100 years.

Dr. TRIVELPIECE. About 100 years or so.

He is the new Director of the Nuclear Physics part of the program. We also have Dr. Don Stevens who, I think, has been with the program forever. He is the new Associate Director for the Basic Energy Sciences Program.

We have, of course, Toni Joseph, who has been the Director of the University Research Program for some time.

Chairman BEVILL. We are pleased to have them here.

Dr. TRIVELPIECE. As you said, Mr. Chairman, I was here the other day to talk about the Department's fusion program. I am here today to talk about the High Energy and Nuclear Physics programs as part of the General Sciences appropriation.

Chairman BEVILL. You failed to present the most important person. Mrs. Trivelpiece is here, I notice.

Dr. TRIVELPIECE. Is she spying on me again?

[Laughter.]

Chairman BEVILL. We are glad to have you with us, too, Mrs. Trivelpiece.

Mrs. TRIVELPIECE. Thank you.

Dr. TRIVELPIECE. Today, we are going to talk about the Basic Energy Sciences Program; the Biological and Environmental Research, and the University Research Programs, which are part of the Energy Supply, Research and Development appropriation.

I have appeared before this Committee several times in the past few years to seek the Committee's support for the Administration's budgets. I have never made any secret of the fact that I am strongly supportive of these programs. I believe that they are essential to all of us in the Nation's science, technology, and educational enterprise.

These programs have been strongly supported by the Congress and by the Administration. I think that's very important. Even in this period of concern over deficit control, we are proposing small increases in the funding for each of these programs.

In High Energy Physics, the program funding is requested to begin the operation of the Tevetron-I facility at Fermilab and the Stanford Linear Collider at Stanford. The Tevetron-I Accelerator has already operated briefly and it set a new record at 1.6 TeV collision energy. The Stanford Linear Collider will provide a copious supply of the recently discovered Z-zero particles and be able to investigate their properties on a more favorable basis.

SUPERCONDUCTING SUPER COLLIDER

We have been funding the Superconducting Super Collider feasibility design efforts for the last three years at about $20 million a year. This year there is no amount that is specifically identified for this activity in the budget.

This has caused some concern that there might have been some change in the Department's position on this project. This is not the case.

Our position was, and is, that this is an important project, but that before proceeding we need to know certain things. For example, how much will it cost? Can it be built with contemporary technology? Are there technical alternatives? What are the site requirements? And so on.

Well, we now have much of this information in hand. We plan to make this known to Secretary Herrington in the near future with the objective of trying to come to some go-no/go decision in terms of requesting construction funding for fiscal year 1988.

Now, depending on the Secretary's decision, we will then make a determination regarding the FY 1987 activities that need to be

done in order to be congruent with any decisions that he might make. This should happen early in the summer, and it will help us in preparing our FY 1988 budget.

We will, of course, keep you informed of the progress.

NUCLEAR PHYSICS

In the Nuclear Physics Program, the principal highlight is the proposed construction start for the Continuous Electron Beam Accelerator Facility. This is affectionately known as CEBAF. It has other names which I will not mention.

This project has been reviewed about as thoroughly as any that I have been involved with. I know you are familiar with some of the details and I don't believe it is necessary to go over them.

I only want to remind you that this project has the support of the nuclear physics community as its highest priority new facility.

We have also made the decision to proceed with research and development to define the characteristics of a Relativistic Heavy Ion Collider at the Brookhaven National Laboratory; however, no commitment has been made to any construction schedule in that regard.

BASIC ENERGY SCIENCE

In the Basic Energy Sciences Program, funding is requested to maintain the core collection of activities at about the same level as this year. The principal highlights of the FY 1987 request involve the Department's proposal to initiate the construction of a 1 to 2 GeV Synchrotron light source at the Lawrence Berkeley Laboratory and to request funds to continue the R&D effort for a 6 GeV Synchrotron light source at the Argonne National Laboratory.

These two projects would fill the really critical need for such facilities in the United States stressed by the Seitz-Eastman Report and, again, endorsed by the Energy Research Advisory Board.

Now, I realize that this is a difficult year in which to be proposing new project starts, but these current budget deficits that we're facing really should not blind us to the long-term need for facilities that are required to keep the United States at the forefront in some of these important areas of basic research.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

The Biological and Environmental Research Program is funded at a level that keeps pace with inflation and it has no particular budgetary highlights. I have gone over some of the accomplishments of this program at past hearings and I wish only to remind you that much of what is known about the potential hazards of nuclear substances and the ability to handle them safely has come from this program; and, also, that 100 million people a year receive either diagnostic or therapeutic procedures that are based on nuclear medicine procedures that owe their existence to activities that grow either directly or indirectly out of this program.

The fact that it has been maintained at a constant level of effort during this period is strong evidence for the support of this by the Department.

Finally, Mr. Chairman, I want to mention the fact that I had the good fortune to meet a young lady from Homewood, Alabama a few nights ago, and this occurred at the Westinghouse Science Talent Search Winner awards ceremony. She was the third-place winner in that very, very difficult competition.

DOE SUPERCOMPUTING HIGH SCHOOL HONORS PROGRAM

Her name is Yoriko Saito; but what is interesting is it turns out this is not the first time I have had the good fortune to meet this very bright young lady. The previous time was at a graduation ceremony that we held for the first DOE Supercomputing High School Honors Student Program. This took place at the Lawrence Livermore Laboratory and involved the Cray Computer at the Magnetic Fusion Computer Center.

This program that we have started was initiated, since I have appeared before you last, by Secretary Herrington. This program was stimulated by him. What happened was last year about this time he had asked me what we could do with our laboratories that would involve high school students in a way that might stimulate their interest and curiosity in a way that would encourage some of them to pursue careers in science and technology.

Well, I got back to him in a few days and sort of vaguely talked about what we might do a year from now, and he said, no. He said, "I mean now." I replied,"Yes, sir," and I proceeded to propose that what we do is to invite the brightest students that we could identify from each of the states and the District of Columbia and Puerto Rico, and ask them to go to Livermore to work for two weeks on this Cray Supercomputer at the Magnetic Fusion Computer Center.

Now, the Secretary agreed with all of this and we carried it out, and fortunately for me the project worked extremely well. This was in spite of having to explain the benefits of doing this to Roger Batzel, who is the Laboratory Director out at Livermore, because the idea of having 50 or more high school students wandering around the Laboratory did not exactly thrill him initially.

He understood the benefits once we explained them to him and, furthermore, having seen what the benefits are, they even volunteered to do this again next year. Recently we have sent out letters to the Governors inviting them to identify students again for the program this year.

Furthermore, we have expanded this program to include one more laboratory. Another 50 students will go up to the Brookhaven National Laboratory and gain some hands-on experimental experience at the National Synchrotron Light Source.

We would like to be able to do it with more, but there's a certain rate at which you can digest these kinds of activities and get them started.

Chairman BEVILL. That young lady from Homewood is typical of Alabama girls.

[Laughter.]

Mr. MYERS. What happened to the boys?

[Laughter.]

Chairman BEVILL. They don't seem to catch up.

How many do you have in the program now?

Dr. TRIVELPIECE. Well, there were 52 last year that went to Livermore and there will be another 52 that go to the Brookhaven National Laboratory for a two-week period. We have given some thought to inviting students from the Summit countries, as well: to have them send students along. I think this would also be of benefit to international exchange.

This activity of using DOE's Laboratories to stimulate bright students to pursue careers in science and technology I think is extremely important. It's not costly and, based on the conversations which I had with the students last year—and I talked to each of them at Livermore—I participated in the graduation ceremony and handed each of them a letter from the President and had a chance to chat a little bit with them— this is certainly the right way to do it.

One of the student's parents wrote. She said that when she greeted her daughter on her return home that her daughter said that "This is the most important two weeks of my life." That sure said it all, Mr. Chairman.

Now I will turn to questions. Thank you.

Chairman BEVILL. Well, that was very interesting. Maybe this program will eventually contribute to our catch-up effort.

It is very disturbing that we have to depend on other countries for so much of our technology. Getting these youngsters interested in science I think is very important.

Dr. TRIVELPIECE. It seems like a simple thing we can do with the facilities that we have available, and I believe it's important.

FUNDING LEVELS FOR GENERAL SCIENCE

Chairman BEVILL. This Committee has been told several times that it is not a good idea, in funding science programs, to cut down one year, go up the next year; that we need to go on somewhat of an even keel.

But I notice that you requested a $45 million decrease in general science last year and, in general science for FY 1987, you requested a $118 million increase.

Could you describe the Administration's approach for the science programs?

Dr. TRIVELPIECE. I think that is consistent with trying to maintain some continuity and stability because, in part, the reductions the previous year were related to the completion of certain construction projects. Those monies would not have been available for operations.

This year, we are asking for about an 18 percent increase which reflects the beginning of operations at Tevetron-I and the SLC projects. There are ups and downs in these programs which have to do with the beginning and ending of construction and the bulge for construction projects.

EUROPEAN HIGH ENERGY PHYSICS PROGRAM

Chairman BEVILL. Would you discuss the progress and future plans of the European High Energy Physics Program?

Dr. TRIVELPIECE. The CERN Laboratory, which is located in Geneva, Switzerland, at the present time has a 310 GeV Proton/

Antiproton Collider; and this experiment, of course, is extremely important. It was the experiment which resulted in the results that Carlo Rubbia, a Harvard professor, received the Nobel Prize for: the W and Z particles. I have mentioned those in past hearings.

They are in the process of constructing a device called the LEP, which is a Large Electron/Positron Collider, and it will have about a 60 GeV collision energy; and I think its construction is expected to be completed somewhere around 1989.

The other major European Laboratory is the DESY Laboratory and it is located in Hamburg, Germany. I was just there a few weeks ago and was able to view at firsthand some of the construction that they have underway in which they are building a tunnel that will pass underneath the city of Hamburg and will contain the accelerator that will be an electron/proton collider and it will have about 30 GeV electrons colliding with 800 GeV protons.

That will provide some new tools for the world facilities. At the moment, they have about a 22 GeV electron collider.

These programs are very healthy and are moving forward, and U.S. physicists are involved in them. We are involved in making some of the detectors and other apparatus that will be used in connection with those facilities.

Chairman BEVILL. We have no operating money in that facility, but is there an exchange of information?

Dr. TRIVELPIECE. We don't have any operating money in those facilities, but we are supplying some of the experimental apparatus that takes advantage of the facility that is there; and, yes, there are people involved in those exchanges.

Notably, in that project is Sam Ting, the U.S. Nobel Prize Winner in Physics, who is concerned with one of the detectors that goes onto the Large Electron/Proton collider at CERN.

CONTINUOUS ELECTRON BEAM ACCELERATORS

Chairman BEVILL. Would you describe the goals and objectives of the continuous electron beam accelerator facility?

Dr. TRIVELPIECE. In the past when I have appeared before you, I have talked about bales of hay and hitting billiard balls, and things like that.

Chairman BEVILL. Well, that is getting it down where this Committee will understand it.

[Laughter.]

Dr. TRIVELPIECE. I will go back to that for just a moment.

Somewhere inside an atom is a nucleus, and inside the nucleus of the atom are protons and neutrons, and inside those are objects currently referred to as quarks. What we would like to know is: Can you cause rearrangements to take place, and what are the characteristics?

We now know that quarks exist and that they are held in there by certain forces. We would like to be able to stimulate rearrangements and investigate the characteristics that they have.

One of the ways to do that is to probe these with highspeed particles, which are, in this case, electrons. The events that occur when these high-speed electrons come in and stimulate the nucleus of the

atom cause possible rearrangements of the objects that are in there, but the events that occur are very rare.

You need to have a large number of electrons in the incoming beam and that is why it needs to be a continuous electron beam—that's part of the name—so that these events, as they take place, are measured by detectors that discover whatever the objects are or whatever the rearrangements are.

The long-term goal and objective of this facility is to have a better understanding of the internal structure of the nucleus of the atom and compare that with some of the models that theoretical physicists who are involved in this field have been developing over the past few years.

This is sometimes referred to as the standard model. It makes certain predictions, and there are things that are implied by it and there are things that people would like to verify in connection with it.

It is one of the tools which will help improve our understanding in that area.

Mr. MYERS. Dr. Trivelpiece, you always impress me and you do a great job, however I share the Chairman's concern that after the first sentence you lose me.

I know you are doing great things but your statement is hard reading.

Dr. TRIVELPIECE. Too dense?

Mr. MYERS. Well, it is something. Either your statement or I am too dense. I went back through it again and I don't know how to ask a question.

THEORETICAL FRAMEWORK

You say, on page 4, that "A major current objective of the High Energy Physics research is the unification of the basic forces into a single theoretical framework." What is a "theoretical framework" in this connection?

Dr. TRIVELPIECE. In this case, I think what is meant is a mathematical structure that you can use to predict the outcome of events that have not yet occurred. I would use the analogy of Mr. Newton and the apocryphal story of the apple falling.

It developed the theory of motion as a means to predict how the moon, the tides and gravity, and all these things work. That was a theoretical framework which explained the mechanics.

Eventually, Albert Einstein introduced into that set of concepts the idea that the speed of light is a maximum speed in the universe and there are certain consequences of that; and that led to the Special Theory of Relativity. Well, that was a new mathematical framework and theory which encompassed not only what Newton did, but also extended it to take into account phenomenon that, at the time of Newton, no one had thought about or had seen.

As the time progressed, then, there were things and theories that involved how radio waves propagate: Maxwell's equations and so on. That was a new theory. It was not just magnets interacting with each other or charged particles interacting with each other; but, in fact, there was an electromagnetic theory to explain all of those things.

As time went by and we began to explore the interior of the nucleus and atoms, it was realized that there is a force that holds the nucleus together, a strong force, and that there are forces that then explain why radioactive substances spontaneously decay.

Each of these appear as sort of separate and disparate theories that are used to explain these things.

What you would like, however, is to be able to have a single theoretical model that can explain all these things in sort of one deft stroke. That was Einstein's dream and he worked most of his life at it. Unfortunately, he did not have all the information necessary in order to make progress at the time that he died; but it was his dream.

Now, the way you can think about this is imagine you have a sphere which is filled with water vapor. It is a very simple theory, a very simple model. In there the water molecules just simply travel on trajectories and they bounce back and forth or they collide off from each other, but it's a gas. There is nothing in there but a gas at that point.

On the other hand, if you cool that down just a little bit pretty soon water begins to condense out. So you have now a mixture of water and of H_2O molecules in the form of a gas, and some of them are going into water and some of them are coming out of water.

You will notice how much more complicated life has become by just simply cooling this down by a few degrees because, now, you need an equation or a theoretical model for explaining how the gas behaves; you need a theoretical model for explaining how the water behaves; and you need to be able to explain how these things go back and forth from one to the other.

If you cool it still further, you get ice and now you have solids and liquids and gases all mixed together transitioning one from another, and you need models to explain all that happening.

So life gets more complicated as you cool this thing down. It's more difficult to explain it.

To some extent, this theoretical model parallels that in the same sense that it is believed that in the early stages of the universe there was a very high temperature associated with the so-called Big Bang, and that the universe has been cooling down ever since.

As a result, we ended up with condensed matter in the form of earth and oceans and lots of interstellar space and so on. We would like to be able to explain this.

We would like a model which can tell you that the forces that are involved in holding the nucleus together, the forces that are involved in the weak interactions that result in radioactive decay, the forces that explain radio waves, the forces that explain gravity—that all of those things really can be put into a very simple framework and explained and understood so that we can understand the universe in which we live.

That's a pretty exotic and esoteric collection of things to be involved: to try to understand what are the most fundamental properties of matter. But it has been a path which mankind has been following for many years since the first time somebody broke up a rock and asked, "What is the most fundamental part of a rock?"

We have come a long way since earth, air, fire and water. Now we can literally say that six quarks and six leptons can be used to

combine in a bewildering authoritative way to literally identify or cause everything we can see in the universe to be explained in terms of what it is made up of: that it takes only six such things of two different kinds to do that.

That is a remarkable step. There is now a theory that goes with that that is referred to as The Standard Model, but it predicts certain things that we have yet to see, and we would like to be able to see them.

Of course, that is tied up with the request for some of the new accelerator facilities that the physicists believe they need in order to make progress in this field.

Sorry for such a long answer to such a short question.

Mr. MYERS. Sure glad I asked that question.

[Laughter.]

Mr. MYERS. I don't think we have time for two questions. Thank you.

Dr. TRIVELPIECE. That was on my time.

MISSION OF HIGH ENERGY PHYSICS

Mr. MYERS. Okay.

That is all good, but is it the Department of Energy's mission to understand how the universe works? Is that really the Department of Energy's mission, to find out why the sun and stars have the gravitational power they have?

Dr. TRIVELPIECE. Well, if you ask me, I would say enthusiastically yes; but, then, you have to ask: What is the origin of the Department of Energy.

Mr. MYERS. It goes back a long way.

Dr. TRIVELPIECE. The Department of Energy and its antecedents go back into the 1930s in which basically these kinds of things were the only thing that what is now the Department of Energy did, such as the Lawrence Berkeley Laboratory's efforts in the 1930s, the work of Lawrence in the cyclotrons and so on, the World War II effort to develop nuclear weapons.

The creation of the AEC had as one of its core elements the requirement to and the desire to pursue this type of basic research. What has it led to?

Nuclear power, nuclear medicine, hundreds of things that have been of inestimable value to the United States and the world. We are now at the same point again of asking these questions.

If there are logical historical reasons for this, I think that the Department of Energy, for one thing, does a very good job at it. I don't see any reason to break up the winning teams.

We might well ask, how did some of the energy things get tacked onto the Department of Energy's fundamental science program, rather than the other way around? But, then, I'm prejudiced.

Mr. MYERS. I have noticed that.

[Laughter.]

Mr. MYERS. You have discovered quarks and leptons, and the other particles. Now you are working on a new theory. Is that right?

Dr. TRIVELPIECE. There's a so-called new force that people are giving consideration to, yes. It says that maybe feathers drop faster than rocks. That is sort of problematical at the moment.

Mr. MYERS. And now you come back the full circle and say there are basically two forces. I did not know what is meant.

But, so what if we find out about quarks? I have asked this question before and that is when you talked about bales of hay and billiard balls. The Chairman and I come from a rural area and we understand hay and billiard balls and lumps of coal.

Again I will ask the question I ask every year. What do we go back and tell that hard-working taxpayer out there who is barely able to put enough money together to put shoes on his children and provide them with an education and pay his taxes?

How can we justify spending his money to find out about quarks and leptons, and that we have two forces? He can go out and put a screwdriver between the posts on his battery and find out that there is a spark.

What have you done in the past year that we can say, "Gee, you are going to have a better life now because Dr. Trivelpiece and his associates found this"?

PAST ACCOMPLISHMENTS

Dr. TRIVELPIECE. Limit me to describing the accomplishments of only the past year and I am in trouble.

Mr. MYERS. We only have one year at a time here in Appropriations, you know.

Dr. TRIVELPIECE. This is a continuum of activities and that some individual you referred to has benefited greatly because everything that he takes and eats or flies in or drives or uses in agriculture, or whatever, in some sense owes its existence to activities that have been supported in the basic research programs not only of the Government, but also of the private industry and the States and other academic institutions both here and around the world.

Our knowledge base is driven by curiosity. I think one of man's most endearing features, outside the need to survive and feed himself, is curiosity.

Where do we come from? Where are we going? How do we get there?

A very real byproduct of that is our ability to make crops that grow better, to understand fertilizers, to understand insecticides, to understand how to use nuclear power safely; and all those things are direct outgrowths of this curiosity.

But right now if you ask, what are the people who are pursuing these exotic and arcane aspects of this doing that is of direct material interest this year? The answer is: That's a bloody hard question to answer, and I don't know how to answer it.

Each year you have given me this challenge and I have not yet found a good answer. I am forever forced to go back and try to identify the things that have happened over the past 10, 15 or 20 years.

But there have been certainly physics discoveries in the past year and there have been new materials, science discoveries and

things like that. All of those are of benefit, and some of those I have mentioned before.

I don't know whether I have mentioned the use of nitrogen ions to harden titanium surfaces in such a way that its wear coefficient goes down by a factor of 400. This is important because that particular type of titanium is what is used in artificial joints, to hip joints.

Instead of having to have those replaced a couple of times in a lifetime if you need one, the fact that you have reduced the wear by 400 means that you only have to do this once.

Dr. Fenton, who is the Director of the Oak Ridge National Laboratory, thought so highly of this particular achievement and even that it was the one thing that he chose to use as an identification of something important the Laboratory has done when he had a chance to greet the President of the United States.

SUPERCONDUCTING MAGNETS

There are things like that that do happen on a contemporary basis. It is hard to find places in any specific program where that occurs specifically, but our ability to have superconducting magnets now—cheap, easily manufactured superconducting magnets—is important because nuclear-magnetic resonance—or magnetic resonance energy as it is sometimes called—is a new noninvasive way of going about finding out where tumors are and other characteristics inside the human body without doing any damage.

In order to do that, you need a magnet which has the volume that is the size of a human being, or nearly the size of a human being. To do that with the magnet that has the required homogeneity in terms of spatial variations of the field and the required stability in order to make those measurements would require prohibitively high cost if you were to do it with conventional magnets.

Whereas, with superconductivity, you can now make such magnets and such VHSIC activities are being used for diagnosis of cancers. That is a direct outgrowth of things that are sponsored by major Department programs.

High Energy Physics now has a superconducting accelerator at Fermilab. As a matter of fact, I think you were there for the dedication of that, as I recall.

Mr. Wynne. Yes.

Dr. Davenport. As an outgrowth of those magnets, which were developed by those scientists in order for them to pursue their curiosity about what quarks and leptons are, the knowledge now improved about making superconducting wire to a tune that now becomes part of a technology effort that the General Electric Company can make magnets that are used for nuclear-magnetic resonance.

They are all connected. The connections are there and we try, from time to time, to write up some of those things and include some of them in our testimony, but I believe that they are there and that they can be justified.

It is very difficult on a year-by-year basis to make identification of activities this year with achievements this year of the sort that you are talking about.

Mr. MYERS. Earlier you mentioned the development of nuclear physics, both for weapons as well as for civilian use. Many people in this country wish we had never developed the weapon system that we have. The Nation, as a whole, is not even advancing the use of nuclear fuel for civilian purposes.

NUCLEAR MEDICINE

Nuclear medicine is one area in which, as you say, a great many people owe their lives. I remember a few years ago we were talking about a nuclear powered heart, but we are not talking about that anymore.

We are still using heart transplants, but we are not using mechanical hearts except on a temporary basis.

Is there any research being done in that area today for people who have faulty hearts?

Dr. TRIVELPIECE. The Department of Energy really is not involved in the clinical aspects of medical research in the sense that you are talking about. We join with the National Institutes of Health in certain cooperative projects in which human subjects are involved.

But there are things in the nuclear medicine research area where the ability to image the heart in either its normal state or damaged state is very important. For instance, one of the new PET scan techniques offers an ability to identify those individuals who are at lower risk if they are to have a heart bypass operation than they might otherwise be.

Some patients are apparently at risk if they have the operation and others are better treated with drugs instead of having the operation. It is just at the threshold of clinical practice now to be able to make that determination before the fact and reduce the risk to patients for whom that type of surgery is required.

Mr. MYERS. In your prepared statement, I believe you discussed the users of the National Labs in this country.

Dr. TRIVELPIECE. There are many users.

USER FEES

Mr. MYERS. We hear a lot about use tax. Do the users pay for the use of the labs?

Dr. TRIVELPIECE. It depends on the circumstance. In some cases, we make the facility available, and the users come in and compete on a scientific peer-review basis for the opportunity to use these facilities.

In other cases, companies—such as, say, Xerox or IBM— if they want to take advantage of the fact that they can use the Synchrotron Light Source at Brookhaven and take away from that the proprietary rights from any information that they develop, then they can pay the fully-burdened cost of operating the facility; and we have an arrangement that makes it possible to do so.

But generally speaking most of the people who use the facilities simply compete for them on an equal-footing basis as scientists and make proposals, and these proposals are peer-reviewed and then they are given time correspondingly.

Mr. MYERS. It is a case-by-case basis, then.

Dr. TRIVELPIECE. Yes, it is.

EUROPEAN COLLIDERS

Mr. MYERS. In the discussion with the Chairman earlier, you talked about the European high energy physics facilities. What are they doing that we are not doing at our facilities?

Dr. TRIVELPIECE. I can answer that question technically. I am not sure that is the thrust of your question.

Mr. MYERS. I just wonder, why is it necessary to have the duplication? Are we doing something they are not doing; are they doing something we are not doing?

Dr. TRIVELPIECE. The device that is being built at HERA is to permit electrons to be collided with protons or nuclei of atoms at very high speeds. There is no corresponding device in the United States.

I think there is some duplication in the following sense. The Large Electron-Positron Collider is a device that will produce collisions of these two types of particles and, to some extent, there is a similarity with that which is going on in Stanford. However, the Stanford device breaks new ground in terms of technology and permits the creation of a copious supply of these new elementary particles, the Z-zeros, in a way that will permit investigation of their properties that is difficult to do if you only have a very few of them coming along.

So there the distinction is, to some extent, technological as well as being driven by the physics. However, the Tevetron-I, which was just recently operated at the 1.6 TeV collisional energy, is a unique facility in the world and there is no other facility that duplicates its characteristics or is likely for some time to come.

Of course, it will eventually operate at 2 TeV of energy in its collisional mode as well as 1 TeV in the mode where the beam is extracted from the accelerator driven out into all those target areas that surround the accelerator.

I think you can count on the fact that the individuals who work in this field are extremely competitive, and they like to do things that are unique and different. There is no point in sort of being the second person to sort of discover the Glutzenstein Effect, or whatever. You would really like to be the first person to discover that particular Effect.

If they look like they are competing in a way that is likely to produce duplicative results, quite frequently one of them goes off and finds something else to do: that there is an attempt to spread out and cover the map rather than for everybody competing for exactly the same thing.

The facilities are built with that in mind and the individuals that work at them practice their craft with that in mind, as well.

Mr. MYERS. I have some other questions. I will put in the record.

In closing, Dr. Trivelpiece, you have always done very well by this Committee. I don't know quite why.

[Laughter.]

Mr. MYERS. You convince us that we just don't know enough about it to question you. But you impress us very much with your knowledge and you keep convincing us.

But what always worries me is that a constitutent will ask.

"Bevill and Myers, why have you been putting money into this project all these years and nothing comes out the end?" I am afraid some American citizens are going to read this, Tom, and wonder what we have been doing all these years.

Dr. TRIVELPIECE. I would like to think it was the right thing.

Mr. MYERS. Well, I would, too.

Dr. TRIVELPIECE. I believe it is the right thing or I would not be here right now.

Mr. MYERS. Mrs. Trivelpiece, we always enjoy having you here. I often wonder, do you come to see if he talks the same way here as he does at home?

[Laughter.]

Mrs. TRIVELPIECE. I do not have to defend my budget at home.

[Laughter.]

Mr. MYERS. Next year, would you give us some questions here?

[Laughter.]

Mr. MYERS. You can sure help us. We will put the old boy on the spot.

[Laughter.]

Mr. MYERS. So I wonder if you come really to find out if he talks the same way here as he does at home over coffee.

Mrs. TRIVELPIECE. He gets so busy this is the only chance I get to see him.

[Laughter.]

Mr. MYERS. He just happened to be passing through Washington today. Okay.

Thank you very much.

Chairman BEVILL. I recognize Mrs. Boggs.

RESCISSION

Mrs. BOGGS. Thank you, Mr. Chairman. Dr. Trivelpiece should Congress fail to approve the Department's rescission of funds for the Universities Lab Program, what would be your schedule for obligating these funds?

Dr. TRIVELPIECE. Well, of course, we were prepared to move rapidly on all the various projects that we have discussed with the Committee in the past; and I think we had prepared to do that. As soon as we have information, we will move rapidly to complete then.

Mrs. BOGGS. What is the status of the Atlanta University Lab? If the proposed rescission expires and funds appropriated in FY 1986 are made available, would additional funding be required for this project?

Dr. TRIVELPIECE. I don't remember the exact status of that, but I think there was something like $4.5 million that had been requested and I know that Atlanta University had sought private funding to match this. I don't remember the exact distribution between them, but I would presume that we would stay with the project and complete it.

I don't know what their needs might be other than that which has already been appropriated and what they have planned for.

ANA MENDEZ FOUNDATION

Mrs. BOGGS. How are things going with the Lawrence Berkeley Lab's science consortium arrangement with Jackson State University and the Mendez Foundation?

Dr. TRIVELPIECE. We have recently received a proposal from them and approximately $1.5 million was set aside for that activity before Gramm-Rudman which translates into $1,443,000 afterwards. It needs to undergo some review. After it does, assuming it meets all the necessary tests, we will proceed with it.

Mrs. BOGGS. Is this type of arrangement beneficial to educational institutions that have historically had student bodies composed of minorities?

Dr. TRIVELPIECE. That is a difficult question to answer because I do not believe there is a sufficiently long established data base from which to draw any conclusions. Some of these things are kind of experimental and the Department is doing different things with its laboratories and historically-black colleges and other minority institutions.

As far as I can tell, I believe they are beneficial; but I think it is something that is going to require some time to pass before the jury will be in on that.

CONTINUOUS ELECTRON BEAM ACCELERATOR FACILITY

Mrs. BOGGS. Please give a status report on the Continuous Electron Beam Accelerator Facility. What are you plans for work on this facility in FY 1987?

Dr. TRIVELPIECE. There is a request for construction start. It is about $25 million for the CEBAF facility and about $6 million in operation. That should begin the construction process.

It is a $236 million estimated-cost facility and it will take several years to complete. I think we are making excellent progress on it at the moment.

As you know, Herman Grunder has come from Berkeley to be the Director of that facility. That is an important addition. They have, now, about 60 staff members on board.

Interestingly enough, the State of Virginia is paying for about 17 additional persons so the Department is getting some benefit from the State of Virginia's direct interest in this activity.

As far as I know, I think everything is going along quite nicely with it; and, in 1987, the construction would begin.

FEDERAL ROLE IN GEOSCIENCES

Mrs. BOGGS. With the drop in oil prices, many domestic oil companies are significantly cutting back on their research departments. In addition, careers in the geosciences are less attractive to college students because of the current cutback in hydrocarbon exploration and development.

Yet all projections show that the U.S. will continue to demand 50 percent of our energy from oil and gas through the year 2010. It seems there is a developing need for a Federal role to continue research into the geosciences associated with the discovery of oil and gas.

Do you agree with that?

Dr. TRIVELPIECE. Yes, in several dimensions.

It is clear that the reduction in oil prices as well as some of the attempted takeovers of one company by another has resulted in a serious reduction in the type of research that some of the oil companies are capable of doing. I think it is a very unfortunate circumstance that has come to pass.

The Department has an interest in the geology and geophysics business in the following sense: that everything that involves energy comes out of the ground, eventually goes back into the ground or it goes into the atmosphere, occasionally it goes into the water and we have to be worried about that from the biological point of view.

But the whole geophysical aspects of things are very important; and this is probably an area where the Department should have some increased emphasis.

Also you may also know, there is a strong interest in this from the proliferation issue: that the detection of underground nuclear tests in order to determine compliance with proliferation is also involved with geophysics in a very important way.

There is a lot of activity the Department has and it probably could be focused to some extent on the geophysical exploration with regard to oil flow.

Mrs. BOGGS. Thank you so much, Dr. Trivelpiece.

Thank you, Mr. Chairman.

Chairman BEVILL. Yes.

Each of us have several questions we would like to have answered on the record, Dr. Trivelpiece.

I know I speak for this Committee. We all consider you one of the most outstanding men that appears before the Committee. We appreciate what you are doing.

It would be very helpful, though, along the lines of Mr. Myers' questioning, if you would furnish for the record the accomplishments that you have made for the past year.

I realize you said they are lengthy, but you went on to name many. It would be very helpful to us because this helps answer the kinds of questions we get. As he just pointed out, these are the questions our constituents give us; and I am sure other Members get the same questions.

We need to know what you have accomplished. We would appreciate it you would do that for the record.

Dr. TRIVELPIECE. Thank you, Mr. Chairman. I would be happy to do so.

And thank you for those kind words.

Mrs. BOGGS. Mr. Chairman?

Chairman BEVILL. Yes.

Mrs. BOGGS. May I thank Mrs. Trivelpiece for being so generous to share husband with us and with the work that he does for the Nation and for the rest of the world.

We are grateful to you as well, Mrs. Trivelpiece.

Chairman BEVILL. Very good point.

Any further questions?

Mr. MYERS. That is all I have.

Chairman BEVILL. This Committee will stand adjourned until 10:00 tomorrow.

[The information follows:]

ACCOMPLISHMENTS - 1985
BASIC ENERGY SCIENCES

1. Mapping Underground Rock Fractures

A new geophysical technique has been used to map the flowpaths of water in fractured rock. The method involves the use of chemical tracers to change the electrical properties of fluids flowing through cracked rock. Sources of radio-like waves are lowered into boreholes and detectors are placed at various locations on the surface. The radio transmissions are measured before, during, and after the introduction of the tracer which affects its strength of the transmission. Variations in the transmission strength can then be used to construct a three dimensional map locating the positions where the tracer flowed. This method has been used successfully in granite to map the water flow paths followed by the tracers. This new technique can be used to map open fractures in rock, to identify water pools and to follow the principal paths taken by water injected into fractured rock systems. "Geotomography" should be able to provide detailed information on geophysical problems which cannot be obtained by any other means.

(Lawrence Livermore National Laboratory, R. Lytle)

2. X-Ray Laser Works

In October, 1984 Princeton University scientists announced the first demonstration of a laboratory-size-x-ray laser. More recently, in March 1985, the next big step, a successful use of mirrors to enhance the x-ray radiation, was achieved. There are many important uses for high-intensity, laser produced x-rays in medicine, physics, biology and technology. In medicine, the finely focused x-ray laser would allow better pin-pointing in the use of CAT scanners and other devices aimed at specific body organs, cancerous tissues or tumors. Physicists could make extensive use of x-ray lasers to measure temperature, impurity densities, and other important factors in fusion experiments. X-ray lasers could substantially improve structural analysis of some materials, and x-ray microscopes would be even sharper than by present-day electron-beam systems.

(Princeton Plasma Physics Laboratory, S. Suckewer)

3. Cleaning Up Water Resources

Polymers similar to those found in every day plastics like styrofoam, are being synthesized which can efficiently remove major or trace amounts of toxic or precious metals from acidic waste streams, rivers, or even sea water. The polymer provides a structure to which the chemically active groups are attached, much as leaves are attached to the branches of a tree. The polymer extractants are actually designed

for the particular metal ions to be extracted and can be synthesized by a relatively simple procedure from inexpensive chemicals. They were devised through a collaborative effort between Oak Ridge National Laboratory and the University of Tennessee. The use of these new extractants is simple, in contrast to present cleanup or recovery systems. The extractants are put into the streams to be to the same job. The extractants are immersed into the streams to be cleaned up and taken out when they become saturated. The metals collected are removed from the extractants so the system can be reused.

(University of Tennessee, S. Alexandratos; Oak Ridge National Laboratory, W. McDowell)

4. New Class of High Resolution Finite Difference Methods Developed to Model Compressible Fluid Flow Problems

Mathematical equations that describe physical behavior are the cornerstone for scientific and engineering advances. Calculus, for example, was developed by Isaac Newton to meet the need he had for describing gravitational forces and the motion of bodies. As science and engineering have advanced, so has applied mathematics. Of particular importance in the applications that have been made in science and engineering is that certain kinds, or classes, of equations show up time after time. A powerful tool to solve them has been the application of computers to actually carry out large numbers of trial and error tests, known as numerical solutions, to arrive at answers. The availability of high speed computers has made numerical solutions extremely valuable in dealing with complex phenomena not heretofore subject to exact solutions. The behavior of gases over a wide range of temperatures and pressures including behavior under drastically changing conditions is of practical interest to physicists and engineers. And recently a new class of numerical methods specifically designed to resolve such problems was developed. Previous computational results were not adequate because of constraints of the computer technology available at the time. These new results are better because they were obtained with updated numerical methods on a modern supercomputer (Cray-1). The numerical analysis of perfect compressible flow is now on an equal footing with experimental methods. These computational tools are an effective alternative to laboratory testing and are being incorporated into large applications programs currently in use at DOE laboratories.

(Lawrence Berkeley Laboratory, P. Colella; Lawrence Livermore National Laboratory, P. Woodard)

5. Understanding the Structure of Plant Cell Walls

Trees and plants comprise the world's greatest reservoir of renewable resources, but the molecular structure of cell walls and functions performed by their parts are far from understood. Recently a better understanding of one component of cell walls, lignin, was achieved. Lignin has been studied with respect to its orientation relative to the other cell wall constituents that make up "lignocellulose". The value of this information is that it will greatly help in our ability to break down the cell walls, to separate and recover the components, and to identify their particular functions. Thus this research has significance in terms of not only understanding fundamental structural nature of these energy resources, but also with respect to developing strategies to overcome existing problems in their use for fuels and chemicals.

(Institute of Paper Chemistry, R. Atalla)

6. Automated Synthesis Technique Developed for Preparing Very Special Alloys

"Magnetostriction" is a change in shape or volume of a material when subjected to a magnetic field; it is a highly desirable property for a number of practical applications. These applications require the material to go through many cycles of being magnetized and demagnetized. Normally, materials lose their ability to go through the cycle fairly quickly. A new alloy was developed which does not lose this ability and a synthesis technique for the new alloy's production has been developed. The technique is automated and a number of uses for it already have been identified. The new alloy is called Terfenol-D. Currently the DOE's Ames Laboratory is the only source for this material which they supply to research and prototype development programs. The projected commercial demand is approximately 2000 kg/yr (up 40 times from the present R&D demand), so a plan has been devised, in concert with industry, to develop and transfer the technology for mass production, and automation. Commercial applications that stand benefit from this new synthesis technique include underground sonar devices for oil field exploration, micropositioners for aiming laser mirrors, fuel injection systems for diesel engines, and robot components such as hands, wrists, and elbows, etc.

(Ames Laboratory, O. McMasters)

7. Cavity Formation and Growth in Ceramics Clarified

Ceramics have become important materials for a variety of structural applications. A phenomenon has been observed however, especially at elevated temperatures, which slowly deforms the material, weakening it and possibly leading to its failure. This phenomenon, called "compressive creep", involves the formation of cavities within the ceramic while under compression. With the goal of improving the performance of structural ceramics and also of predicting their lifetimes, cavity formation and its growth has been studied using the powerful techniques of neutron diffraction. It has been possible to obtain detailed information of how the cavity is started, and how it grows during "compressive creep". These studies indicate that accurate predictions of the lifetimes of ceramic components at elevated temperatures can be made only when reliable models of cavity formation and growth are combined with proper failure criteria. Better models are currently being developed using these results.

(Southwest Research Institute, R. Page)

8. Model Molecules Designed as a Step Toward Artificial Photosynthesis

A significant advance in the quest for an artificial photo-synthetic system has been achieved: the chemical synthesis of a model "photoreaction center". A photoreaction center — a molecule or a group of molecules — absorbs light energy, which causes an electron to move from one end of the reaction center to another. This "charge separation" initiates the chemical reactions of photosynthesis. It is a critical step in triggering the whole photosynthetic process. In nature chlorophyll is at the heart of the photoreaction center. Light is absorbed followed by rapid electrical charge separation involving other components in the photoreaction center. A key feature of nature's system is that the charge separation takes place in several successive steps. By learning how to control the length of time (still exceedingly brief) that the charges are maintained apart before they recombine a whole area of using photosynthetic-like processes to carry out useful chemical reactions may be opened up.

(Argonne National Laboratory, M. Wasielewski)

9. Changing Chemical Properties of Catalysts

Until now, studies of catalytic reactions of gases or liquids on solid surfaces could measure only the changes taking place in the molecules affected by the solid catalytic surface. Although detailed studies of surfaces of solid catalysts have been carried out, the dynamic effects that the catalytic reactions have on the catalytic surface itself have not been determined and nothing specific could be concluded about that aspect of catalysis. Now it has been experimentally demonstrated, through studying carbon monoxide gas adsorbed on the surface of a nickel catalyst, that the carbon monoxide actually does modify the chemical properties of the nickel surface. These experiments provide an important new capability for quantitatively evaluating the effects on catalytic properties of substances added during or after the manufacture of catalysts. This is very important to understand because when catalysts lose their properties, they have to be replaced, and costs are very high.

(University of Pittsburgh, J. T. Yates)

10. Separating Coal "Macerals" of High Purity

In building the knowledge base for future conversion of coal to substitute fuels or chemical feedstocks, we face some difficult facts: each coal in a coal deposit is unique in its chemical and structural makeup, and each coal is a distinct, chemically complex mixture. Coals contain organic substances called "macerals" which may be thought of as the basic building blocks of coal. The different set of macerals in each coal have origins in different plants and plant parts, such as leaves, stems, seeds or spores. Now, a method has been developed for separating the macerals of a coal sample from each other. This new method is a mechanical separation taking advantage of the differences in density between the macerals and other constituents of coal to separate them from one another. Providing maceral samples or know-how for separating them is leading to many collaborative studies with university and industrial laboratories by Argonne National Laboratory.

(Argonne National Laboratory, G. Drykacz, K. Vorres)

11. Preventing Neptunium From Moving in the Soil

Neptunium, a long-lived radioactive element produced as a by-product of nuclear power, has been considered to be more of an environmental hazard in nuclear wastes than other actinide elements (elements of atomic number 90 through 103). This is because a particular chemical

form of it binds less strongly to soils and thus is is more mobile in ground waters than other actinide species. The potential concentration of neptunium in ground water is extremely low; recently advances in electrochemical measurements of actinides in extremely dilute solutions have shown that under attainable conditions in ground water, and at the extremely low dilutions that neptunium might be found in, neptunium can exist in a state that is much more readily immobilized by soil. Thus there is now reason to believe that the hazard posed by neptunium may be less than previously anticipated.

(Oak Ridge National Laboratory, L. Maya)

12. New Catalysts Derived Based on Naturally Occurring Zeolite Selectivity

Iron-based catalysts, called Fischer-Tropsch catalysts, have been the workhorse for the petroleum and petrochemical industries for conversion of crude oil to products like gasoline. Research has been focused on understanding how catalysts work with the goal of improving their selectivity. Zeolites are naturally occurring materials with an open structure of molecular dimensions that have been found to be selective in admitting certain sizes or shapes of molecules into their open structures. This property of selectivity can be controlled through altering the zeolite's composition and dimensions. The selectivity of a zeolite and the properties of a Fischer-Tropsch catalyst have been successfully wedded in this work. The new method for producing iron particles on zeolites is a promising new direction, and is potentially applicable to using other elements, for important energy-related catalytic processes.

(Argonne National Laboratory, L. Iton)

13. New Static Ultra-High Pressure Record: Studies of Hydrogen and Deuterium

Hydrogen and deuterium have been pressurized to 1.47 million atmospheres (1.47 megabars)! This was done to investigate experimentally a very fundamental theoretical prediction that hydrogen will become metallic, and then superconducting, at extremely high pressures. Until recently, it has not been possible to obtain pressures greater than 0.7 megabars. Metallic properties of hydrogen and deuterium were not observed, although measurements made at 1.47 megabars do suggest that these materials will become metallic: this

was not clear from experiments at 0.7 megabars. Theoretical predictions for the onset of metallic proerties lie in the range from 0.7 to 2.1 megabars. This kind of research is very much at the cutting edge of science, leading to new phenomena never before observed.

(Carnegie Institution of Washington, P. Bell, H. Mao and coworkers)

14. High Pressure Studies Show Rare Behavior of Bonding in Actinide Metals

A discovery has been made of a scientific phenomenon rare in the metallic elements. It has been seen in the actinide series of elements, and it provides insights into the understanding of electronic structure and chemical bonding of all the elements. The electrons surrounding an atom are perceived as "orbiting" its nucleus, and the "outermost" electron is typically the first one to participate in chemical bonding, i.e., the energy needed to "delocalize" it is less than for the rest of the electrons in the atom. Nomenclature for the orbits in which the electrons are found is complex; it is sufficient to note that only in the elements protactinium, uranium, neptunium, and plutonium do the "5f" electrons participate in metallic bonding at ordinary pressures. The first clear evidence has been obtained that metallic chemical bonding can be induced by enormous pressures in elements above atomic number 94, plutonium. It was found that when extreme pressures squeeze the atoms together, at a certain threshold pressure for each higher atomic number element studied, the "5f" electrons enter metallic bonding, volume collapse occurs, and the crystal geometry suddenly changes.

(Oak Ridge National Laboratory, R. Haire; University of Tennessee, J. Peterson)

15. Fast New Mathematical Method Devised

Complex mathematical computations, considered hopelessly unworkable even with the aid of the most powerful supercomputers, can now be handled with the development of a fast, accurate, new procedure. The key step is the identification of frequently appearing terms in a large addition problem together with a method for estimating how often a given term appears. This new method called "Successive linkage" can provide exact answers to certain problems, and reliable approximations to others. It has already been used to evaluate thermodynamic quantities for physical models of materials.

(Lawrence Berkeley Laboratory, A. Chorin)

16. New Model of Ore Formation Also Looks Good for Oil Exploration

Successful petroleum exploration is becoming more and more dependent on methodical identification and evaluation of extensive data to assess a possible oil field's potential. Two expensive methods, drilling and seismic studies, are the most common means of data gathering. New techniques for data interpretation that demand less data input or lead to more reliable assessment could significantly decrease oil prospecting and production costs. Studies of related chemical and physical movement phenomena that occur under particular geochemical conditions have led to a novel computer program that models not only what minerals are present in a basin but also the processes over time that have led to their current locations. From the geochemical history at a given location, estimates are made regarding the previous conditions in the basin and its suitability for oil production. The model is based on actual processes and faithfully adheres to fundamental physical and chemical laws. The incorporation of this practical modeling technique into petroleum companies' exploration programs could result in a significantly enhanced discovery success rate.

(Geo-Chemical Research Associates, P. Ortoleva)

17. First High Resolution Study of Magnetic Structures Accomplished Using X-Ray Scattering

Brookhaven National Laboratory scientists, working at the Stanford Synchrotron Radiation Laboratory with high-intensity X-rays, and using neutrons from their own High Flux Beam Reactor, have completed a comprehensive study of the structure of the magnetic field within a single crystal. Using these tools, particularly the application of high resolution X-ray scattering techniques, they found it possible to observe the very faint X-ray diffraction due to perturbations of the magnetic field's structure and symmetry in relation to the atoms and electrons in the holmium crystal. Understanding magnetic structures and their dynamics is important to improving scientific concepts of magnetism and to the development of technologically significant magnetic materials.

(Brookhaven National Laboratory, D. Moncton, D. Gibbs and coworkers)

18. New Organic Metal Superconductor Successfully Designed, Synthesized and Characterized

Based on principles established in earlier work, a new metal-organic compound with improved superconducting properties was designed and

synthesized. Tests of the superconducting properties of this new compound were favorable. The continuing aim of this research is the development of new superconducting synthetic organic metals with a potential for use in electronic systems.

(Argonne National Laboratory, H. Wang, M. Beno, U. Geiser, G. Crabtree, K. Carlson, J. Williams; Sandia National Laboratories, L. Azavado, J. Kwak, J. Schirber; Strem Chemical Co., M. Strem, F. Wagner, C. Sielicki)

19. New Light Thrown on Destructive Noise in Heat Exchangers

Heat Exchangers which play an important role in energy production and utilization systems are often the sources of extremely high noise levels, harmful to both man and machine. With a clear understanding of the underlying processes involved, it may be possible to develop a rational method for designing low noise, efficient heat exchangers instead of applying noise reduction methods in trial and error fashion. In a recently completed series of experiments, the precise nature of intense noise generation in exchanger tube bundles has been determined. The improved understanding of the mechanism of noise generation will lead to better design capability for future energy efficient, non-noise polluting heat exchangers.

(GA Technologies, R. Blevins)

20. Experiments Lead to Better Models of Natural and Forced Convection

The transfer of heat is fundamental to the production and utilization of energy. Heat — thermal energy — is used to convert the chemical energy released in burning coal or oil, the atomic energy released in fission or solar energy to electricity, or is used directly. Improving the ability to both use and transfer heat more efficiently is of major practical importance. Computers are used extensively to calculate heat transfer in energy systems, and, because of its complex nature, simplifying assumptions about heat flows are always necessary; this introduces some uncertainty. The only way to make sure such calculations are correct is through actual experiments but suitable methods have not been available to carry out the complex experiments needed. Recently, techniques for simultaneously following fluid flow and temperature have been developed and applied experimentally. The improved knowledge has now been incorporated in new computer models of flow and heat transfer which are thoroughly tested for accuracy and should be widely useful for designs of important types of heat

exchangers. As these results become more widely distributed, their inclusion in the stock of engineering knowledge and practice will serve to improve the efficiency of many energy production and utilization systems.

(Stanford University, R. Street)

21. Underground High Heat Flow Area Site Studies

Several years ago, a nationwide search was made for sites likely to give the greatest understanding of areas of unusually high heat flow below the earth's surface. One of the sites chosen was Long Valley in California which shows clear signs of continuing volcanic activity. A deep layer of volcanic ash from the initial eruption seven hundred thousand years ago, is spread hundreds of miles along the eastern side of the Sierra mountains. The most recent major eruption took place about 600 years ago. In 1982, a new vent releasing high pressure hot gases opened, and the seismicity of the area has increased significantly in recent years. A relatively small DOE research effort has stimulated an important effort to develop a three-dimensional picture of the subsurface structure and distribution of molten rock under Long Valley. Four Federal agencies, the state of California, seven universities and several industrial firms have participated in cooperative studies as part of what has now evolved, under DOE leadership, into a national Continental Scientific Drilling Program. Investigations have revealed the details of a complex inter-relationship among the occurrences of earthquakes, the ongoing deformation of this collapsed volcano and the shape of the molten rock chamber below it. The results are significant for improved hazard analysis, for better geothermal resource assessment, and for determination of an optimal location for a deep borehole to obtain more detailed scientific information.

(Sandia National Laboratory, J. Rundle and 21 collaborators)

22. The Pigment Phytochrome was Recently Shown to Exist as Two Distinct Molecules

The role of light in plants is not limited to photosynthesis; light also controls many aspects of plant growth and development. These effects range from the promotion of flowering to stimulation of seed germination to the spacing of leaves on a stem. Many of these nonphotosynthetic light effects have been shown to be influenced, if not controlled, by a substance called phytochrome. Recent studies have led to the identification of a previously unknown phytochrome form in light-grown plants. There appears to be a different protein associated with the phytochrome found in plants

grown in light in comparison to that in plants grown without light. The protein from light grown plants is being isolated and chemically studied to learn more about the chemical mechanisms that are involved in the light-induced regulation of plant growth and development, factors critical to potential increases in plant productivity and ultimately enhancement of available renewable resources.

(University of Wisconsin, P. Quail; University of Georgia, L. Pratt)

23. Possibility of Tritium Breeding in Fusion Reactor Blankets Confirmed

The fusion reaction converts hydrogen to helium releasing a considerable amount of energy. Several different reactions actually occur, depending on reaction conditions and the hydrogen isotopes involved. Tritium, a heavy, radioactive isotope of hydrogen, is a particularly valuable fuel material but is not found in nature in quantities needed on an engineering scale. To provide tritium on the scale needed requires its production through nuclear reactions involving other elements. One particularly attractive scheme is designed to make use of those neutrons produced during the fusion process itself but which escape from the primary fusion reaction containment vessel. This vessel is surrounded by lithium containing target material to capture the escaping neutrons and react to produce tritium. The surrounding target material is called a "blanket"; the concept itself is referred to as "tritium breeding". The possibility of producing tritium this way was confirmed experimentally at the Lawrence Livermore National Laboratory Rotating Target Neutron source.

Lawrence Livermore National Laboratory Rotating Target Neutron Source
(Lawrence Livermore National Laboratory, R. Haight)

24. Theory of Novel Semiconductor Compounds

Theoretical predictions of important characteristics of two novel classes of materials have been made. The theoretical methodology established the first microscopic description of these semiconductors and was able to predict which specific alloys in these classes would be stable. Application of similar theoretical models led to the prediction of 22 new semiconducting compounds with attractive physical properties for potential energy technology applications. These successes offer insights into the creation of new complex semiconductor materials with vastly improved properties.

(Solar Energy Research Institute, A. Zunger)

25. Specific Transmission and Expression of Foreign Genes in Plants

Through new techniques in the biological sciences, it is becoming possible to selectively modify genetic materials and introduce new or modified characteristics into plants and microorganisms. Development of these techniques offers much promise for the "genetic engineering" of plants to alter yields of particularly valuable energy crop components, to more easily grow plants under marginal soil or climatic conditions, or to reduce energy requirements for cultivation. Such a procedure was successfully carried out at Rockefeller University, working in collaboration with researchers in Belgium. In this work, a highly significant new new procedure has been demonstrated for introducing "foreign" genes into plants and effectively influencing the manifestation of their genetic messages in the plant.

(Rockefeller University, A. Cashmore)

26. Million-Degree Microexplosions

A unique method for examining the effects on surfaces of rapidly changing pressures, densities and very high temperatures, has been developed. Research has been underway on how "clusters" of hundreds of atoms or molecules, each "cluster" having only a single electric charge, form. Beams of these clusters have been made to collide with surfaces in less than 0.1 trillionth of a second, generating a temperature of about 1,000,000° Celsius in the solid surface. This development provides an important new tool for investigating properties of assemblies of atoms or molecules in very dense, hot plasmas. It also has been found that the impact of the beam produces very small holes of 2 to 4 ten-millionths of an inch in thin carbon films. The hole size and the number of holes produced per unit area are adjustable depending on the beam intensity. This new technique, "cluster ion impact", besides providing an important new research technique, also is a promising technique for preparation of microholes for a variety of applications.

(Brookhaven National Laboratory, L. Friedman)

27. New Chemical Extractant Discovered for Treating Nuclear Wastes

A new solvent extraction process has been developed which might reduce by a factor of a hundred the volume of nuclear fuel wastes which must be subjected to long-term storage or ultimate disposal,

such as burial. The new process uses a chemical which was designed and synthesized to be highly selective for removing actinide elements from acid solutions. This process is currently being evaluated for pilot plant testing. In full operation, ultimate savings of several hundred million dollars can be expected from reduced waste burial costs and improved recovery of plutonium from reprocessing streams. Further savings are also anticipated from other reprocessing applications of this novel chemical system.

(Argonne National Laboratory, P. Horwitz)

28. Energy-Saving Chemical Process Discovered, Patented and Moved Quickly from University to Industrial Use

A new synthetic process was developed which uses low cost, energy-saving safer calcium as a substitute for hazardous, costly sodium metal for producing a unique organic chemical. The synthesis has the added advantage of high yields of the products. The patented process has reached commercialization in less than 2 years from the discovery. The new process produces monoenes which are used in large volumes in the chemical industry. Most of them are relatively simple and can be produced without resort to the new type of chemistry. But some monoenes, used in production of medicines, are structurally complex molecules. Production of more complex types of molecules will be greatly improved and rendered more economical by this invention.

(Purdue University, R. Benkeser)

29. New Mechanism Identified for Hydrogen Induced Failure

Direct observations in the electron microscope of hydrogen induced fracture of solids under stress have shown that many of the commercially important metal alloys do not fail because hydrogen makes them brittle. Hydrogen enhances the local plastic behavior of the metals and failure results from greater local deformation. Recognition of the mechanism of this type of failure will allow improvements in both the design of alloys and systems for use in hostile environments and in the prediction of lifetimes of engineering systems. Hydrogen induced failures are responsible for the loss of billions of dollars of engineering systems and even for the loss of lives each year. These failures generally occur well within the "safe limits" of the operating parameters for the materials and occur unpredictably after a period of service. In the past, attempts to protect against this type of failure were based on ad hoc solutions and were mostly unsatisfactory.

(University of Illinois, H. Birnbaum, I. Robertson)

30. Method Developed to Produce Soluble Conducting Polymers

Recent advances have demonstrated that non-metallic, organic polymers can be produced that conduct electricity. Polyacetylene, a solid produced from acetylene gas, is the best known example, but there are others. A major challenge in developing suitable applications for polymeric conductors has been to fabricate them into selected forms without adversely affecting their conducting properties. Soluble polymers permit a detailed molecular characterization of conducting polymers. This characterization is needed to guide efforts in the design and synthesis of better conducting polymers. Also, the processing of conducting polymers can be studied because soluble polymers can be fabricated into a variety of shapes.

(Los Alamos National Laboratory, M. Aldissi, R. Liepins, A. Nyitray, A. Bishop, D. Campbell, S. Mzumdar)

31. A New Steel Wire with Superior Properties and Reduced Cost

Superior properties and reduced cost have both been achieved with simple modifications in the processing procedures used to make steel wire. In steel, iron combines with carbon in different, but reproducible, atomic ratios forming several different species that can be present at the same time. The properties of steel depend on the species present, their relative proportions, and the uniformity of their dispersion throughout the steel. Beginning with low-carbon steel rods, a drawing operation has been developed which produced a material with two finely dispersed iron-carbon species in a final structure with extremely high tensile strengths The process has been successfully implemented in existing commercial rod-mills. It requires no additional capital investment and because it makes the traditional heat treatments obsolete, actually results in substantial savings. This breakthrough has significant potential for improving the international competitiveness of domestic steel speciality products. The combination of high strength, good formability, and improved low temperature ductility in these wires gives them great potential for such applications as tire cord in steel-belted radial tires. No expensive alloying additions are required and the procedures have already been successfully tried at a commercial Stelmore wire-rod production line. Patents have been awarded and licensing agreements are currently being arranged.

(University of California, Berkeley, G. Thomas and graduate students)

ACCOMPLISHMENTS
BIOLOGICAL AND ENVIRONMENTAL RESEARCH

Source and Dose Determination

ADVANCES IN MEASUREMENT SCIENCE AND DOSIMETRY

Innovative instrumental techniques are increasingly being used for biomedical applications such as the characterization and quantitation of organic carcinogen-DNA adducts and for the measurement of actual dosages experienced by receptors following exposure to carcinogens. The dosage is determined from measurements of the carcinogen's metabolites present in urine and blood samples. DNA adducts associated with carcinogen benzo[a]pryene have been detected and differentiated from the adducts formed by different metabolic routes.

A new instrument to measure x-ray emissions, characteristic of radioactive elements like plutonium, has been developed. For the first time, soil samples can be checked for low levels of radioactive contamination in one place. The operation can be done within minutes, or at most, a few hours. In contrast, current detection techniques, which rely on complex, costly chemical separations, often take weeks. By using an array of six silicon detectors to measure the emissions over a period of time, the amount of a particular radioactive material can be determined. Special shielding reduces the effect of background gamma rays, making the new detector four times more sensitive than previous detection systems. A modified version of the detector for use in monitoring the lungs of workers exposed to plutonium is presently being developed.

Through developments in laser and supercritical fluid (SFC) analytical technology, we have been able to measure the concentrations of potentially hazardous radionuclides and very large organic molecules at concentrations far lower than was previously possible. We have also been able to demonstrate the measurement of isotopic ratios of certain fission products, thereby establishing techniques that should be applicable to many of the potentially hazardous radionuclides associated with nuclear power generation and nuclear weapons production. Our developments in SFC have provided a basis for both the separation and the analysis of very large and highly polar molecules that were not amenable to analysis by other means. We have thus developed a new technical basis for the rapid and selective analysis by other means. We have thus developed a new technical basis for the rapid and selective analysis of many of the potentially hazardous materials that are generated in the nuclear and synthetic fuels industries. The combination of these extremely powerful analytical techniques with other conventional methods such as mass spectrometry, can form a basis for real-time analysis of effluent streams and ambient air.

Environmental Processes and Effects

PARTICULATE AND ACID DEPOSITION EFFECTS IN FORESTS

Scientists in the Environmental Sciences Division at Oak Ridge National Laboratory have found that reactions of acids with forests occur as rainfall passes through the canopy. Through the combined efforts of atmospheric scientists, geochemists and forest ecologists, the effects of these reactions on forests are being studied.

Gains and losses of all major chemical ions were determined for three forests in eastern Tennessee that are currently receiving wet and dry acidic deposition. For all three canopies, the retention of atmospherically deposited cations (particularly hydrogen and ammonium ions) exceeded retention of deposited anions. Charge balance was maintained by ion exchange between the deposited cations and ions on the canopy surfaces. Because the cation exchange can be largely attributed to retention of deposited hydrogen ions, it represents a direct effect of the acidic deposition on forest chemical cycles.

In addition, dry deposition was found to be an important source for most of the major cations and anions. The data indicate that organic anions may be important buffers to cation leaching, especially in the absence of acidic deposition.

The DOE is currently concerned with possible effects of acidic precipitation in forests because of the significant contributions of fossil fuel burning, in the overall atmospheric balance of acids and other chemicals. Maintenance of healthy forests is vital, not only for the direct production of lumber, paper, and other forest products but also for the ecological importance of forests.

PROCEDURES FOR ESTIMATING RUNOFF, EROSION, AND CONTAMINANT TRANSPORT IN SEMIARID WATERSHEDS

Predicting the hydrologic response of semiarid watersheds is particularly challenging because precipitation, runoff, and erosion are highly variable in both time and space. We have developed a simple procedure from a synthesis of mathematical models to describe and predict runoff, sediment yield, and contaminant transport in a radionuclide-contaminated stream channel on the Los Alamos National Environmental Research Park. The radionuclides associated with the stream channel sediments were used to evaluate the performance of the model.

The procedure was used to estimate the outflow and residual inventories of plutonium in the channel over a 38-year period from 1942-1980. Calculated residual plutonium inventories in stream channel sediments compared within a factor of about 2 with inventory estimates based on intensive sediment sampling and chemical analysis for plutonium.

Given the relatively good agreement between the calculated and measured plutonium inventory, predicted changes in plutonium storage in the canyon were made to the year 2000. Results of that analysis, along with ancillary information, were used by management in an environmental evaluation to determine the need for remedial action to remove the contaminated sediments from the canyon. The final decision to leave the sediments in place saved the Laboratory, DOE, and the public several million in unneeded remedial action costs.

SAFETY ANALYSIS FOR NASA ON THE FATE OF PLUTONIUM USED AS A POWER SOURCE IN SATELLITES

Several of the staff and contractors of OHER studied the risks of accident of space-craft carrying plutonium as a heat source to generate electricity for deep space projects, and the consequences to the aquatic environment of contamination from plutonium-238. With help from our popular book, Transuranics in the Environment, and plutonium experts among our contractors, we completed a safety analysis of Projects Galileo and Ulysses that was written up and accepted early this year.

Successful and prompt conclusion of the safety report was made possible because contractors in the southeastern U.S. had studied the currents off Cape Canavaral, to learn how contaminants carried down the Savannah River from energy operations upstream are moved offshore; research showed that plutonium particles sink to the bottom and attach to sediments, and bottom sediments are scoured by storm conditions, sometimes taken offshore into deeper water, and sometimes carried up on shore by waves. Thus we recognized potential danger from dust from beach roads.

On the other hand, we could give assurance that transfer to human through the marine food chain would be minimal, based on our studies of food chains around Enewetak in the Marshall Islands.

Our study showed that the Banana River, near the Cape, would be the most vulnerable aquatic environment, because of its slow flushing rate and the presence of many larval fishes. The committee called for monitoring of this area, and suggested that in the event of satellite failure NOAA's Bureau of Marine Fisheries close the area for fishing until plutonium in the environment dropped to safe levels.

Our safety analysis was on schedule and one of the first completed, receiving almost no criticism, because data were available to back up our speculations on the fate of plutonium and its hazards to mankind.

PROCESSING OF EMISSIONS BY CLOUDS AND PRECIPITATION

Three major field experiments have been conducted as part of the PRECP (Processing of Emissions by Clouds and Precipitation) program. The PRECP program represents a major part of the DOE involvement in the National Acidic Precipitation Assessment Program (NAPAP). The scientific objective of PRECP is to understand the mechanism by which sulfur and nitrogen oxides are converted to sulfuric and nitric acid in clouds and rain. The experiments involve a broad range of surface and aircraft measurements of chemical reactants in the air entering and leaving and within the clouds and in the cloud water and in rain drops (or snow). Meteorological measurements are made at the same time in order to couple the atmospheric dynamics and atmospheric chemistry. Experiments centered in Ohio were conducted in April 1985. The PRECP program participated cooperatively in the pre-STORM experiments of NOAA in Oklahoma in June 1985 in order to take advantage of the extensive meteorological measurements which were made in pre-STORM. A third series of experiments was conducted in Syracuse in January-February in order to study winter time lake-effect storm.

The data from these experiments are being used to develop a model of chemical transformation and removal of sulfur and nitrogen pollutants. This model will then provide the basis for a heterogeneous transformation and removal module that will be part of the NAPAP complex 3-D Eulerian Regional Acidic Deposition Model (RADM) under development by EPA. The RADM will be the major national tool for assessment of "acid rain" effects.

Health Effects and Biological Processes

NEW GENETIC DISCOVERIES IN LEUKEMIA RESEARCH

Dr. Janet Rowley of the University of Chicago, School of Medicine, continues to have success in discovering additional patterns of chromosome aberrations which are linked to malignant diseases--especially leukemia and lymphoma. She has also been highly successful in combining the new techniques of oncogene research with her prior experience with these malignant diseases. In addition to the rearrangement between chromosomes 9 and 22 in chronic myeloid leukemia which she discovered in 1973, she and her colleagues have more recently identified four other structural rearrangements that recur in patients with acute myeloid leukemia. One of these, an inversion of chromosome 16, has provided an opportunity to bridge the analysis of leukemia at the microscopic level with the new molecular analysis of DNA. In this past year, she has established a new clinical-cytogenetic association, namely the presence of an increased number of basophils in the bone marrow of patients with acute myeloid leukemia whose malignant cells also have a translocation involving chromosomes 6 and 9. It is of interest that the breakpoint in chromosome 9 in this aberration is in the same band as that in chronic myeloid leukemia, a disorder also associated with an increased number of marrow basophils.

She has also shown that the leukemic cells from patients who were previously treated with cytotoxic agents such as radiation and/or chemotherapy for a pre-existing primary malignant disease had a very high frequency of loss of chromosome No. 5 and/or 7. She suggests that these two chromosome changes potentially could be used as markers for identifying acute leukemia that might be associated with mutagenic exposure. Two other observations that corroborate these findings are: (1) these aberrations are rare in children, (2) they are more common in the leukemic cells of patients who worked in industries where they were exposed to potentially mutagenic substances than in those not so exposed, such as housewives or white collar workers.

PROTEIN ALTERATIONS AS MEASURES OF INDUCED MUTATIONS

Scientists at the Argonne National Laboratory have shown that two-dimensional (2-D) electrophoresis can be used as an effective screening technique for heritable mutations. Classical methods for estimating the potential risk of such mutations as a result of accidental or occupational exposures, however, are very limited. Techniques that measure chromosome damage provide information about possible consequences but do not demonstrate functional changes. On the other hand the most used test in mice monitors only seven genetic loci, and thus requires large numbers of animals in order to achieve the required sensitivity. Proteins are the products of gene expression; thus, altered protein composition can result from genetic

damage. Two-dimensional electrophoresis separates proteins on the basis of differences in both charge and molecular weight. Currently, this technique can reproducibly resolve more than 500 proteins in each individual analysis. The Argonne scientists have used 2-D electrophoresis to analyze the proteins in liver homogenates prepared from the offspring of male mice treated with ethylnitrosourea, a known mutagen in mice, and have identified four mice out of the 240 analyzed thus far with expressed mutations. Three of the four mice appear to be normal but express charge variants of specific proteins. The fourth mouse has a dramatic skeletal abnormality, and several proteins not normally found in the liver were observed in the analyses. The heritability of the mutations has already been demonstrated for two of the four cases, with 50% of the offspring resulting from the test-cross expressing the altered proteins. In a similar study conducted at Oak Ridge in which the mouse test was used, one mutation was found per 217 mice compared to the one in 60 detected at Argonne by 2-D electrophoresis. Thus, this pilot study has demonstrated that 2-D electrophoresis can efficiently detect heritable mutations induced by a chemical agent. Studies are now in progress to determine the feasibility of detecting mutations induced by gamma rays. Future studies will involve the analysis of different types of ionizing radiation and hazardous chemicals.

LARGE AMOUNTS OF PROTEIN BY GENETIC ENGINEERING

Practical applications of genetic engineering have been achieved through the expression of foreign DNA in bacterial cells. Most of these applications have been accomplished through the use of the common bacterium Escherichia coli in which the foreign gene is expressed. A new system for making large amounts of RNA and protein in E. coli has been developed. This system uses the RNA synthesizing enzyme of T7 bacterial virus to direct virtually all RNA synthesis in the cell to a single target gene, and large amounts of the protein gene product can be accumulated in a relatively short time. Genes from a wide variety of cells can be expressed in this system. Because the T7 RNA synthesizing enzyme acts so selectively, it might also provide the basis for similar expression systems in types of cells other than E. coli. Thus this system might be extremely useful in accomplishing the large scale synthesis of particular proteins.

NOSE FOUND TO BE IMPORTANT SITE OF INTERACTION WITH INHALED TOXINS

The nose is usually the first tissue of the respiratory tract to come in contact with inhaled foreign compounds, but until recently, it has been largely ignored as a major site of interaction with inhaled material. Recent work at the Inhalation Toxicology Research Institute (ITRI) has shown that nasal tissues have a high content of metabolic enzymes that can either act to convert toxic compounds to nontoxic ones or can convert organic compounds into compounds that can bind to the genetic material (DNA) and potentially cause cancer. There is evidence that the nose has the ability to metabolize a broad range of foreign compounds. The major site of this metabolic activity is the olfactory region of the nose, where odors are perceived, and the enzymes may be a part of the olfaction process. Work at ITRI has also indicated that inhaled particles are cleared less rapidly from the olfactory region than from other areas of the nose. This indicates that particle associated foreign compounds would have an enhanced chance of

interacting with the nasal metabolizing enzymes. While the liver is a major site of similar types of metabolic activity, the metabolic capacity of the nasal region may play a major role in the fate of inhaled airborne contaminants at low levels, when materials may never reach the liver. Chronic exposure to low levels of material is the most common exposure scenario in the work place or home environment. In current experiments, chemical probes are being used to inhibit the nasal enzymes selectively (and not the liver enzymes) to determine the role of the nasal enzymes in the total metabolic capacity of the body.

HUMAN DNA REPAIR GENES

In cells, damage to the genetic material (DNA) from radiations or chemicals is usually repaired. This is done by specific proteins. Repair is an extremely important, but poorly understood, process. Lack of repair can lead to heritable mutations in germ cells and can trigger cancer in other cells of the body. In certain human genetic disorders, the individuals are known to have a greatly elevated risk for developing cancers. When analyzed, the cells of these people show defects in the ability to repair DNA molecules. In cultured rodent cells, a series of mutations that prevent DNA repair were produced, making the cells very susceptible to mutation and killing by DNA-damaging agents. Thus, these rodent cells are very similar to the cells from some of the human cancer-prone disorders. By fusing the mutant rodent cells with human white blood cells to give hybrid cells, the rodent cell mutations could be corrected. In the hybrids, human chromosome 19 was identified as the chromosome responsible for correcting three different mutations. Purified DNA taken from human cells also has been introduced into the mutant rodent cells. Again, human repair genes are able to function and correct the defects in those rodent cells that contain them. The process of transferring a human repair gene is repeated so that cells which have no other human genes are obtained. The DNA from those cells is then processed by genetic engineering techniques to recover the specific human repair gene. With this approach many different human genes that govern the repair proteins can be isolated. The genes can then be used to identify and study the repair proteins.

NEUROMAGNETOMETRY

Neuromagnetometry, an interdisciplinary project at the Los Alamos National Laboratory has as its goal the development and application of technology for noninvasive monitoring of activity in the brains of humans and experimental animals. Advanced superconducting quantum interference devices (SQUIDs) are used to detect the magnetic fields associated with current flow in small clusters of brain cells (neurons). With appropriate measurement technique and the use of algorithms for signal deconvolution, the spatial location of the source can be determined; an array of seven SQUIDs has been designed and fabricated. This array will allow measurements to be made without moving the detector and will greatly facilitate the localization of neuronal signal sources. On the basis of recently-completed measurements, generator sites for three components of the auditory evoked response have been newly identified. Experiments currently underway will determine the sources of activity associated with attention and with decision processes. Other technology, such as the measurement of electrical evoked responses, cannot

be used to obtain this information. The experiments will result in a description of the spatial distribution of activity in the brain, and will greatly increase our understanding of sensory and cognitive processing. These data have significance for diverse problems, including the localization and characterization of central nervous system pathology and the development of processing algorithms in artificial intelligence.

ONCOGENES IN RADIATION CANCER

The cells of every individual contain genetic information which has cancer-forming potential. In healthy individuals this genetic information is important for normal physical growth and development. Exposure of this genetic material to either physical agents (e.g., sunlight, radiation, etc.) or chemicals can alter the genetic information and result in cancer. There is evidence which suggests that cancer-causing agents (carcinogens) may produce characteristic changes in the cells' DNA which convert normal genetic information into "oncogenes" or genes which cause cancer. The question we are asking is: Does radiation cause changes that are distinct from those caused by chemicals? If so, a precise characterization of the "fingerprints" left in the tumor cells by the carcinogen would allow the development of methods to either implicate or eliminate radiation as a causative factor in a given tumor. In order to test this hypothesis, we must determine whether oncogenes are activated in radiation-induced cancers and, if so, whether activation is a cause or effect of the cancer development.

Normal and cancer tissues from plutonium-exposed animals are being used to examine the role of oncogenes in radiation carcinogenesis and to determine whether radiation causes distinctive patterns of genetic changes. Such patterns should exist if oncogene activation is a causative factor in cancer development. The DNA from eight lung tumors (all of those studied to date) transformed noncancerous cells into cancerous cells. Normal tissues from the same dogs did not transform the indicator cells. These data strongly suggest that oncogenes are a causative factor in these tumors. Further examination of the DNA from these plutonium-induced lung tumors detected tumor-specific changes in oncogene-related DNA fragments that supported the hypothesis that the oncogenes were changed as a result of exposure to radiation. Having identified the oncogenes involved, we are characterizing the nature of the changes and how they affect the cell. Specifically, we are determining whether "oncogene activation" was caused by increased synthesis of the oncogene products or resulted in a gene product with altered activities.

Nuclear Medicine Applications

BRAIN TUMOR DETECTION WITH POSITRON EMISSION TOMOGRAPHY

A major new breakthrough in the detection of human brain tumors was made this year with the completion of eight pilot studies of cancer patients using the new tracer, 1-^{11}C putrescine [^{11}C-PUT] and positron emission tomography (PET). This tracer, which probes the increases in the biosynthesis of polyamines which accompanies tumor growth, not only provides a new perspective on the difference between normal and tumor cells, but is

also able to detect small hypermetabolic tumors and to reveal their degree of malignancy. This is reflected by the uptake of ^{11}C-PUT which is far greater for active, high grade tumors than for low grade tumors. While ^{11}C-PUT's uptake into tumors is useful in cancer diagnosis and prognosis, it is the absence of uptake in normal brain tissue which sets it apart from the more commonly used PET tracers. Thus on examining a PET image of a brain tumor with ^{11}C-PUT, one sees a very high contrast between the tumor and the rest of the brain, making both diagnosis and prognosis straightforward. Parallel studies of tumor glucose metabolism in each of these eight patients generally showed less difference between the metabolic activity of the tumor and the metabolic activity or normal brain tissue with some tumors actually being less active metabolically than normal brain tissue. This general approach to measuring both polyamine metabolism and glucose metabolism in the tumor can be used to track responses to radiation therapy and to chemotherapy.

CEREBRAL DISEASE DETECTION

The ability to measure physiological, biochemical, hemodynamic and pharmacologic cerebral processes noninvasively be means of positron emission tomography (PET) has resulted in the unique opportunity to study, in normal subjects, the response of the human brain to a variety of behavioral (visual, sensory, auditory, motor, memory and cognitive) tasks as well as responses to drugs. While informative in and of itself, these studies in normals provide validated tasks to apply in patient populations where they can be used as probes to stress the brain and make more obvious latent abnormalities in cerebral physiology, test the functional reserve of neuronal systems and understand the recovery of function after brain injury. Baseline studies of disease processes has provided new and previously unavailable insights into the fundamental mechanisms of human epilepsies, dementing processes (including Alzheimer's Disease, multiple infarct dementia and pseudodementia), neurodegenerative diseases such as Huntington's and Parkinson's Disease, inborn errors of metabolism (Von Gierke's Disease), cerebral tumors, and stroke. These investigations have provided some of the earliest information now available on the local changes in brain function that accompany the manifestations of neurologic disease. Through the PET technique we have been able to identify lesions that are more extensive and occur at earlier times in the course of the disease than structural imaging techniques (conventional radiology, conventional nuclear medicine studies, computed tomography or magnetic resonance imaging) have previously allowed. Additionally, these investigations have demonstrated changes that even precede the clinical symptoms in inherited neurologic diseases such as Huntington's Disease.

CARDIOVASCULAR DISEASE DETECTION

Studies with positron emission tomography have been providing a wealth of new information about the metabolic and biochemical basis of human cardiovascular disease, the largest single killer in America. In 50% of people with coronary heart disease, the first symptom is sudden death. Thus, there is an urgent need for a diagnostic technique that is sensitive to the earliest changes that occur in the unsymptomatic stages, and for study of

certain risk factors, such as hypertension, smoking, high blood cholesterol and fatty acid levels. Various existing conventional technologies, such as electrocardiography, nuclear medicine studies, angiography, and ultrasound, can diagnose the presence of developed heart disease quite well, although early detection by these techniques is difficult. Detection of mild cardiovascular disease has been demonstrated with positron emission tomography. This technique has also demonstrated its value for the determination of therapy, such as bypass surgery. The important issue is whether tissue is live and has survived the initial attack. This is a biochemical or metabolic question for which only positron tomography has shown capability to directly make the evaluation. Recently, studies have been carried out in patients before and after bypass surgery. In all cases where it was indicated from positron emission tomography that tissue was not viable, it did not recover. In patients where it was indicated that the tissue remained viable, the patients did recover.

RECENT HIGH ENERGY PHYSICS PROGRAM PROGRESS

Experimental Studies and Tests of the Standard Model of Elementary Particles and Fundamental Forces

Extraordinary progress has been achieved in the field of elementary particle physics during the last several years. Of particular importance have been the confirmation that hadronic matter is composed of quarks; the observation and measurement of weak neutral current interactions; the discovery of the charmed quark, the bottom quark, and the tau lepton; and the direct observation of the W and Z gauge bosons. These results, combined with equally impressive theoretical developments, have led to the formulation and substantial verification of an elegant theory (The Standard Model) describing the electromagnetic, weak, and strong interactions. There are however, very important features of this theory which have not yet been fully tested. In particular, the Standard Model predicts the existence of at least one particle, the "Higgs" boson, which has not been observed.

The experimental programs currently under way, or planned for accelerators under construction, are broad based and rich in their possibilities; we mention only a few of the highlights. At Fermilab, the existence of a wide variety of high energy secondary beams now available from the Tevatron upgrade provides one of the best opportunities to study heavy quark production, high energy neutrino interactions, and CP violation. The first runs with the superconducting accelerator yielded a precise result on the decays of sigma hyperons, thus, resolving a long-standing conflict between theory and experiment in favor of the Standard Model. Precise rare K decay measurements yielded precision tests of CP violation and tests the assumption of the Standard Model that there are only 3 generations of quarks and leptons. A precision measurement of upsilon state production is resolving clearly the lowest three states of the upsilon. The proton-antiproton collider Tevatron I), with a center-of-mass energy of nearly 2 TeV, obtained its first collisions in fall 1985 with the CDF detector. The first regular physics run will begin late in 1986.

At BNL, the intense low energy beams allow sensitive tests of CP violation, and searches for very rare kaon decays, and these experiments are continuing with high priority. Also at BNL, a neutrino interaction experiment has yielded the most accurate measurements of neutrino cross sections to date, as well as the best value of the weak mixing parameter of the Standard Model. Another neutrino experiment is completing data runs designed to put stringent limits on neutrino oscillations, and yet another is just beginning its data runs. An experiment utilizing the new polarized beam capability at the AGS has measured anomalous polarizations in hard proton-proton scattering which is a challenge to understand in the framework of the Standard Model. Other experiments have measured anomalously large production of two-phi states, which appears to violate an empirical rule suppressing such mechanisms.

At SLAC, the primary future physics thrust is on the SLC e^+e^- collider which will provide very precise measurements of the Z mass, width, and coupling constants as well as detailed studies of Z decays. Much progress is being made in upgrading the Mark II detector which will finish its test run at PEP by March 1986 and then prepare to move to the SLC interaction region where it will take first data in the region of the Z^o. At PEP and SPEAR, many exciting results are emerging each year. At PEP, the TPC detector found a new particle, the F*; the Mark II detector made very precise measurements of the D^+ lifetime; the HRS detector measured the electroweak asymmetry parameter as predicted by the Standard Model; the ASP detector has measured the best limits on the masses of conjectured particles called supersymmetric particles (see below). At SPEAR, the Mark III detector has measured rare decay modes of D mesons.

Theoretical physics has also been extremely productive during the year. The emergence of Superstrings as a possible unified theory of all forces burst upon the physics scene and is described below. In addition, the work utilizing supercomputers to calculate particle masses and other properties from first principle is exciting.

Superstring Theories - An Approach to the Unified Description of All Fundamental Forces

Theoretical physicists from Caltech, Princeton, and Queen Mary/London are investigating new types of theories, called "superstring theories," which may well lead to a revolutionary development in our understanding of the fundamental nature of matter and energy. It has been found that certain theories of vibrating strings hold the scientifically exciting possibility of showing the way to a unification of all the basic forces of nature, including gravity. In the past, the most fundamental objects usually have been considered to be "point" particles, which have no finite extent and have been given names such as quarks and leptons. In superstring theories, the fundamental objects are viewed as extremely tiny, stiff strings of length about 10^{-35} meters--so tiny that in fact they appear point-like on larger scales. This almost inconceivably miniscule extension in size appears to cure many of problems which have persistently plagued other theories. Also, because only a very limited class of superstring theories is possible, the task of finding the "correct" one which corresponds to Nature is greatly reduced. This very promising development is still in its early stages and experimental verification of any theoretical predictions will, of course, be both crucial and necessary.

The ASP Experiment at SLAC - A Search for Physics Beyond the Standard Model

A number of approaches have been taken toward constructing models that reach beyond our present Standard Model understanding. One class of theories postulates that a "supersymmetry" exists between fermions (particles such as quarks and leptons) and bosons (including mesons and force-carrying particles such as photons, gluons, and weak vector bosons). These theories

may provide an explanation for the vast difference between the mass scale of gravity (10^{19} GeV) and that of weak interactions (10^{2} GeV), and they provide a satisfying symmetry between matter and radiation.

A startling prediction of this idea is that there must be entirely new, unobserved particles with masses less than a few hundred GeV and perhaps within the range of present-day accelerators. These new particles would be partners to the known particles and are given names that are similar to the partners' names. A likely candidate for the lightest supersymmetric particle is a partner of the photon, called the photino. This particle, if it exists, could be produced in pairs in high energy electron-positron collisions. The photinos, once produced, are predicted to interact only weakly in matter and are, thus, not seen directly by experimental detectors. A fraction of these photino-pair events, however, is expected to be accompanied by the radiation of a single photon by one of the beam electrons. This photon can be used to "tag," or signal, the production of the photino pair.

A special purpose detector called ASP (Anomalous Single Photon) was built to look for events that consist of a single isolated photon produced by $e^{+}e^{-}$ collisions at the PEP storage ring. This effort is a collaboration of physicists from SLAC, Boston University, and the University of Washington. The experimenters reported their first results at an international conference in August 1985 and will complete the accumulation of data in the spring of 1986. No positive signal of possible photino-pair events above background has yet been observed. This result does, though, already show that either the mass of the photino must be greater than 12 GeV or the mass of the partner of the electron, called the "selectron," must be greater than 50 GeV.

Improved Superconducting Wire

Research and development studies into the basic metallurgy of niobium titanium, the most commonly used alloy in commercial production of multifilamentary superconducting wire, have resulted in significantly improved performance. A University of Wisconsin research team, led by Professor David Larbalestier and funded by the DOE Division of High Energy Physics, has been studying the metallurgical properties of niobium titanium which determine the maximum critical current density obtainable in commercially produced superconductors. The results of these studies are communicated at seminars held semiannually with U.S. manufacturers and DOE high energy physics national laboratory groups. These provide the opportunity for early multilateral exchanges of information on the R&D and its impact on wire performance, without the normal delay experienced through publication in technical journals. At the same time, the proprietary interests of the participating U.S. industries are preserved. The effort is further augmented

through procurement activities managed by DOE high energy physics groups at the national laboratories. As part of their development programs, these laboratories purchase and test wire produced by methods based on the results of the University of Wisconsin R&D.

As a result of this team effort, present performance of multifilamentary niobium-titanium superconductor produced by U.S. manufacturers is 30 to 40 percent better than the performance of wire produced in quantity for the Fermi National Accelerator Laboratory Energy Saver superconducting accelerator storage ring. This improvement results from the above DOE-supported efforts and comes about through the use of high homogeneity niobium-titanium and improved heat treatment and cold work sequences in the manufacturing process.

The best material produced in the University of Wisconsin laboratory performs 60 to 75 percent better than the Energy Saver wire, and it is anticipated that this performance can also be achieved in industrial production. The next goals of the team are to achieve similar current densities in very fine filament wire and to push critical current density to over twice the performance of the Energy Saver wire. The improved performance is of major importance to the design and cost of the Superconducting Super Collider (SSC).

Tevatron Proton-Antiproton Collider

A six week test run of Fermilab's superconducting accelerator in the collider mode culminated in October 1985 in the detection of about a dozen identified interactions of protons with antiprotons at a new world-record reaction energy of 1.6 trillion electron volts (TeV). The antiprotons were collected and accumulated in the new Antiproton Source complex. Beams of 800 GeV protons and 800 GeV antiprotons were brought into head-on collision at the center of the massive new Collider Detector at Fermilab (CDF), which recorded the reaction products and established that the collisions had occurred. Shortly after this highly successful test run, the Fermilab accelerator complex was shut down for a period of about nine months to permit completion of the final civil construction work for the Tevatron facilities at Fermilab. When completed, the Fermilab Tevatron collider is expected to produce collision energies of 1.8 to 2 trillion electron volts, three times the energy capability of any other accelerator.

Stanford Linear Collider

Major technical progress was made in 1985 in the development and fabrication of key components for the Stanford Linear Collider (SLC) which is being constructed at the Stanford Linear Accelerator Center (SLAC). This collider will provide an essential demonstration of the new linear collider concept for the study of very high energy electron-positron

collisions. Successful demonstration of this concept is a critical step toward a future cost-effective extension of electron-positron reaction energies well beyond the maximum energy practical with circular electron accelerators and storage rings. The SLC will also provide early access to the important physics in the energy region in which Z^0 particles are produced. The Z^0 particle is one of a family of particles that carry the electroweak force.

In the past year, there have been several important advances in the development and fabrication of specialized technical components for the SLC construction project and for the SLC research program. These include the manufacture and testing of new higher power microwave tubes which are required to increase the energy of the electron and positron beams to 50 billion electron volts each; the fabrication of almost 1,000 bending magnets required to steer the electron and positron beams into head-on collision in a one-micron diameter spot; and the modification and testing of an existing major particle detector at SLAC, the Mark II detector, preparatory to its use to observe the reaction products of the high energy electron-positron collisions which will be produced by SLC.

Superconducting Super Collider (SSC)

Design and R&D activities for the SSC have accomplished much this past year in better defining this proposed 20-TeV proton-proton collider facility. These accomplishments have been the result of a national effort with important contributions from laboratories, universities, and industry. This work has been coordinated by the SSC Central Design Group led by Professor M. Tigner.

The R&D work has concentrated on the superconducting magnets to be used for the facility. This work has built on the firm base established by the highly successful construction and operation of the Tevatron with its more than three miles of superconducting magnets. In 1984, the Reference Designs Study (RDS) considered SSC designs based on three types of magnets. Extensive experimentation with model magnets established that the magnets can be built using industrial techniques to reliably give the required high quality magnetic field. Following a detailed study, a high-field (6.6 Tesla) design combining the best features of previous designs has been chosen as the optimum choice for overall cost and technical considerations.

In parallel with the work on magnets, R&D at the University of Wisconsin has allowed an improvement by a factor of about one and a half in the current-carrying capacity of the wire, while at the same time improving its characteristics to give a more uniform magnetic field at the time of injection of the beams into the collider. As discussed earlier this technology has been transferred in a highly successful manner to U.S. industry, thus greatly improving U.S. competitive capabilities in the world superconductor market.

In arriving at the designs and cost estimates of the 1984 Reference Designs Study, several key technological assumptions were made. These have now been verified experimentally, and in some cases, such as the current-carrying capacity of ths superconducting wire, exceeded. The amount of refrigeration required to maintain the superconducting magnets near absolute zero was calculated for the SSC design to be a factor of 5 to 10 less per unit length than for the Tevatron. A heat leak model developed and tested at Fermilab in 1985 verified these calculations and assumptions.

RECENT NUCLEAR PHYSICS PROGRAM ACCOMPLISHMENTS

COMPRESSIBILITY OF NUCLEAR MATTER

An equation of state is a formula relating the temperature, density, and phase (solid, liquid, or gas) of a material. For example, the freezing of water at 32 degrees and boiling at 212 degrees provide information about the equation of state of water. Atomic nuclei occur naturally only in a single phase, resembling tiny drops of cold liquid of extremely high density. To completely understand nuclei, other phases must be investigated. Nuclear densities and temperatures can be increased for very short times and with great difficulty by accelerating heavy ions to high speeds and colliding them with other nuclei. The consequences of the resulting compression and heating can be understood by measuring and interpreting the nuclear fragments from the resulting splash. A recent accomplishment, which required use of nuclear heavy ion accelerators, measured the compressibility of hot, dense nuclei and found that it was much stiffer than for nuclei in their normal state. This is in sharp and unexpected contrast to the descriptions of the way stars die in supernova explosions. In this case the nuclear density is very high but the temperature is about normal. Extensive supercomputer calculations found that supernovae require nuclear matter to be very spongy for the explosions to proceed. Work is now proceeding in order to reconcile the two diverse findings.

NEUTRINO-ELECTRON SCATTERING

The LAMPF facility at Los Alamos provides the world's best source of electron type neutrinos. These elusive particles, with no electric charge and no measured mass, have recently been used to test the Standard Model of nuclear forces. The standard model incorporates the latest concepts of the strong nuclear force involving quark and gluons. It also includes the electroweak force, which combines the electromagnetic force and the weak interaction (responsible for beta decay of nuclei) into a coherent picture. However. the connection between these two forces, and with the gravitational force, is still conceptually beyond the standard model. At LAMPF, the intense beam of neutrinos was scattered from electrons in order to test the limits of the standard model predictions. The results were in agreement with that model. So far, no experiment in nuclear physics or high energy physics has provided any clue to how to proceed with the unification of the different forces.

SPONTANEOUS POSITRON EMISSION

In extremely high electric fields, quantum theory has long predicted that electron-positron pairs can be spontaneously created. In the collisions between slowly moving uranium nuclei, science has its first opportunity to create high enough electric fields to test this prediction. Scientists from Yale University, collaborating with researchers at the GSI accelerator facility in West Germany, have indeed found such spontaneous creation. This creation has occurred in the very surprising form of a sharp energy peak, possibly signifying the formation of a new and unexpected elementary particle.

ACCOMPLISHMENTS

UNIVERSITY RESEARCH INSTRUMENTATION PROGRAM

The University Research Instrumentation Program (URI) was initiated by the Office of Energy Research in FY 1984 as part of an interagency response to help alleviate the growing problem of obsolescence of scientific research instrumentation available on university campuses. The URI program is specifically focused on supporting on a competitive basis requests from university scientists who are significantly involved in DOE-sponsored research for state-of-the-art scientific instruments costing over $100,000. A total of 40 awards have been made in the URI program since its initiation. The average award size has been $240,000. Typical scientific instruments supported in the URI program include high mass, high resolution spectrometers; scanning Auger microprobes; high resolution electron microscopes and laser diagnostic systems. Cost sharing is required from universities seeking to participate in the URI program.

UNIVERSITY RESEARCH SUPPORT PROGRAM

The University Research Support Program (URS) includes a number of program activities which are designed to strengthen the ability of universities and university faculty and students to contribute to DOE's energy R&D needs. A major focus of URS effort revolves around the use of the research facilities and resources at the DOE laboratories and contractor research facilities for faculty and student research and education. Accomplishments in the URS program during FY 1985 are as follows:

- Supported 2,300 faculty and student research and training appointments at 30 DOE laboratories and research facilities. This total includes 1,100 undergraduate science and engineering students participating in summer research at the laboratories.

- Provided refueling for six university nuclear research reactors and continued to support the use of these reactors for research and training purposes by faculty and students at colleges and universities that do not have a reactor facility.

- Initiated support for a unique cost-shared visiting industrial scientist program at the DOE laboratories. Twelve appointments were made in FY 1985 at seven DOE laboratories. The purpose of this effort is to build stronger ties between the laboratories and private industry and to enhance the transfer of laboratory-developed technology to the private sector.

- As part of the Department's commitment to the national goal of strengthening our educational system, support was provided for a series of precollege science teacher and student programs. This included the use of laboratory research facilities for high school teacher/student training. The major activity in FY 1985 was the High

School Supercomputing Honors Program held at the Lawrence Livermore National Laboratory. Fifty two high school science students (selected by the Governors of each state including Puerto Rico and the District of Columbia) spent two weeks at Livermore learning about supercomputers and their use and potential in research.

MULTIPROGRAM ENERGY LABORATORIES-FACILITIES SUPPORT

The Multiprogram Energy Laboratories-Facilities Support program has two subprograms: General Purpose Facilities (GPF) and Environmental Compliance at ORNL. The GPF subprogram was started in FY 1981 and provides construction funds for the rehabilitation, renovation and replacement of general purpose facilities at multiprogram laboratories. In FY 1985, nine new projects were started and three projects were completed. These completed projects include a laboratory office building at Idaho National Engineering Laboratory, a site utilities project at Lawrence Livermore National Laboratory and an energy technology laboratory at Sandia National Laboratory.

The Environmental Compliance and Upgrade subprogram at ORNL was established late in FY 1985 via a reprogramming action of $5.4 million. The subprogram addresses the serious environmental noncompliance issues at ORNL. In FY 1985, numerous studies and assessments to determine the full scope and nature of the environmental contamination were initiated. And, various corrective actions were taken such as those related to the integrity of the sewer system.

TECHNOLOGY TRANSFER

In performing their assigned tasks, the Department's laboratories make many discoveries which have technical or commercial value. It is the Department's policy to identify these discoveries and make them available to industry and others. During 1985, several inventions were licensed to different industries and new instruments were developed, as shown in the following examples:

- o A instrument was developed to help teach deaf persons to speak by converting sounds into visual displays;
- o An invention which speeds up and simplifies the separation of red blood cells has been licensed to a company;
- o An exclusive license was given to a company for a method to remove metal from fly ash;
- o A method developed by DOE of producing stretched membrane mirror systems has been adapted for use in a small solar powerplant by an industry.

The following questions and answers were provided for inclusion in the record:

SUPERCONDUCTING SUPER COLLIDER

Mr. BEVILL. Last year, a major issue in your budget involved the Superconducting Super Collider (SSC). This year your budget includes no specific funding for the project. Please describe the Administration's position on the SSC.

Dr. TRIVELPIECE. R&D on the SSC is progressing well and has had significant successes. The SSC Central Design Group, with participation from the laboratories, universities, and industry, is in the final stages of preparation of a detailed Conceptual Design Report. This report will contain a detailed design, with costs and schedule, based on the results of the R&D program. The Department, using this input, will conduct a very thorough review this spring of the entire scientific, technical, and cost aspects of the SSC. This review will serve as important input to the Department's decision this summer on whether to seek authorization to initiate construction of the project in FY 1988 or some future year. The direction and emphasis of the FY 1987 accelerator R&D program will depend on the results of this review. It is, therefore, premature to assign a specific number to SSC R&D in FY 1987, and thus, the budget request does not identify specific funding for the project.

Mr. BEVILL. The Superconducting Super Collider (SSC) appeared to be a very high priority project last year and very low priority this year. Has the project experienced technical difficulties or political problems?

Dr. TRIVELPIECE. Not at all, we view the SSC as an outstanding and high priority project. The R&D has been highly successful, and as indicated earlier, we plan an indepth review of the project this spring and a decision this summer on whether to seek authorization to initiate construction in FY 1988.

EUROPEAN HIGH ENERGY PHYSICS

Mr. BEVILL. Please discuss the progress to date and the future plans of the European High Energy Physics program.

Dr. TRIVELPIECE. The European high energy physics program features proton-antiproton colliding beams at the European Laboratory for Particle Physics, CERN, at 310 GeV per beam. Research at this machine resulted in the discovery of the W and Z particles, the predicted carriers of the weak nuclear force, and was recognized by the award of the 1984 Nobel Prize in Physics. The search for new phenomena and new particles such as the top quark is continuing at CERN. At the Deutsches Elektronen-Synchrotron—DESY—the electron-positron colliding beams facility. PETRA, with 22 GeV per beam, has investigated fundamental aspects of electromagnetic interactions, discovered jets arising from gluons as predicted by the theory of strong interactions, and observed the interference of the weak and electromagnetic forces as predicted by the Standard Model.

For the future, CERN is constructing the Large Electron-Positron, LEP, collider project for electron-positron collisions at 60 GeV per beam by 1989. A follow-on second phase to increase beam energy to about 120 GeV per beam is planned immediately following the first phase. DESY is constructing the Hadron-Elektron-Ring-Anlage, HERA, for colliding beams of electrons and protons with 30 GeV electrons on 820 GeV protons, to be finished by 1990. In Italy, the Gran Sasso underground facility is a unique, world capability presently being completed for a variety of non-accelerator experiments such as proton decay and monopole searches.

The U.S. is participating, or planning to participate, in experiments utilizing these world-unique facilities. The U.S. has the lead role in one major collaborative experiment at LEP, the L3 experiment led by Nobel Laureate S.C.C. Ting of the Massachusetts Institute of Technology. Also, the U.S. has the lead role in a large monopole collaborative experiment, MACRO, in the Gran Sasso facility in Italy led by B. Barish of the California Institute of Technology.

JAPANESE PROGRAM

Mr. BEVILL. What is the size of the current Japanese program and what are the expected plans for the future?

Dr. TRIVELPIECE. The Japanese program in high energy physics currently operates at an annual level of about $175 million. This includes the operation of the accelerator facilities at KEK, a major international laboratory for high energy physics at Tsukuba, a scientific city about 50 miles north of Tokyo. Construction of an electron-positron colliding beam facility, TRISTAN, with 30–35 GeV per beam, is in progress at KEK. This new facility is scheduled to begin operation in November

1986. A detector for a U.S.-led collaborative experiment, AMY, is under fabrication with participation of U.S. scientists from the University of Rochester, Virginia Polytech, Louisiana State, South Carolina, and Ohio State as well as scientists from Japan and elsewhere. In addition, the Japanese contribute about $7 million per year for work at U.S. accelerator centers through the US/Japan Cooperative Program on High Energy Physics, including R&D on advanced accelerators, detectors, and the Superconducting Super Collider, SSC. Expected future Japanese plans include an upgrade of TRISTAN to higher energy and, perhaps, participation in the SSC if the U.S. proceeds with the project.

MOTOR VEHICLES

Mr. BEVILL. Please provide the justification for purchase of 12 replacement motor vehicles in the General Sciences appropriation. Please indicate where these vehicles are to be located.

Dr. TRIVELPIECE. The Department's FY 1987 General Science and Research budget request includes the purchase of 12 motor vehicles which, due to age and maintenance costs, are no longer economically feasible to retain. The High Energy Physics program has responsibility for funding all general purpose equipment requirements at Brookhaven National Laboratory where six passenger vehicles and one ambulance require replacement. The Nuclear Physics program provides funding for all general purpose equipment requirements at Lawrence Berkeley Laboratory where two passenger buses require replacement. In addition, three passenger vehicles require replacement at Fermilab.

SMALL BUSINESS INNOVATION DEVELOPMENT ACT

Mr. BEVILL. Please describe how the Small Business Innovation Development Act is administered within the Department.

Dr. TRIVELPIECE. The Small Business Innovation Research Program is managed at the Department of Energy by the Office of Basic Energy Sciences within the Office of Energy Research. An annual solicitation is issued containing about 26 technical topics drawn from the R&D interests of the Department with the exception of Defense Programs which is exempt from Small Business Innovation Research. A rigorous two-step technical review of proposals is designed for early elimination of unsuitable proposals and critical evaluation of potential winners using advice from experts in the field. Awards are based on scientific and technical merit, irrespective of the technical topic under which a proposal is submitted. The scientific and technical quality of Small Business Innovation Research projects is excellent, and Department of Energy technical managers certify that the quality is comparable to that of projects in their regular programs.

FORWARD FINANCING

Mr. BEVILL. Please provide a table showing Forward Financing for this appropriation by activity and location for FY 1984, FY 1985, FY 1986, and FY 1987. The table should distinguish the various components of forward financing.

Dr. TRIVELPIECE. I would like to insert in the record a table showing Forward Financing for this appropriation by activity and location for FY 1984, FY 1985, FY 1986, and FY 1987.

[The information follows:]

FISCAL YEAR 1984 FORWARD FINANCING

[In millions of dollars]

	Commitments	Prefinancing
High energy physics:		
Ames Laboratory	0.1	0.1
Argonne National Laboratory	.3	.1
Brookhaven National Laboratory	3.3	3.7
Fermilab	5.5	2.0
Lawrence Berkeley Laboratory	1.5	.5
Los Alamos National Laboratory	.1	.0
Oak Ridge National Laboratory	.1	.0
Stanford Linear Accelerator Center	2.3	6.5

FISCAL YEAR 1984 FORWARD FINANCING—Continued

[In millions of dollars]

	Commitments	Prefinancing
Nuclear Physics:		
Ames Laboratory	.1	.0
Argonne National Laboratory	.4	.6
Brookhaven National Laboratory	.3	.5
Lawrence Berkeley Laboratory	1.2	2.6
Los Alamos National Laboratory	2.8	2.7
Oak Ridge National Laboratory	.2	1.1

FISCAL YEAR 1985 FORWARD FINANCING

[In millions of dollars]

	Commitments	Prefinancing
High energy physics:		
Ames Laboratory	0.1	0.1
Argonne National Laboratory	.4	.4
Brookhaven National Laboratory	3.5	3.5
Fermilab	4.6	4.3
Lawrence Berkeley Laboratory	1.5	.4
Los Alamos National Laboratory	.1	.0
Stanford Linear Accelerator Center	2.5	6.1
Nuclear physics:		
Argonne National Laboratory	.2	.7
Brookhaven National Laboratory	.4	.5
Lawrence Berkeley Laboratory	2.3	1.1
Los Alamos National Laboratory	3.1	1.0
Oak Ridge National Laboratory	.1	1.0

FISCAL YEAR 1986 FORWARD FINANCING

[In millions of dollars]

	Commitments	Prefinancing
High energy physics:		
Ames Laboratory	0.1	0.1
Argonne National Laboratory	.1	.4
Brookhaven National Laboratory	3.1	2.2
Fermilab	4.0	4.9
Lawrence Berkeley Laboratory	1.4	.4
Los Alamos National Laboratory	.1	.0
Stanford Linear Accelerator Center	3.0	4.5
Nuclear physics:		
Argonne National Laboratory	.2	.8
Brookhaven National Laboratory	.5	.0
Lawrence Berkeley Laboratory	2.3	1.1
Los Alamos National Laboratory	3.1	1.0
Oak Ridge National Laboratory	.1	1.0

FISCAL YEAR 1987 FORWARD FINANCING

[In millions of dollars]

	Commitments	Prefinancing
High energy physics:		
Ames Laboratory	0.1	0.1
Argonne National Laboratory	.1	.4
Brookhaven National Laboratory	3.2	2.1

FISCAL YEAR 1987 FORWARD FINANCING—Continued

[In millions of dollars]

	Commitments	Prefinancing
Fermilab	3.8	5.1
Lawrence Berkeley Laboratory	1.6	.4
Los Alamos National Laboratory	.1	.0
Stanford Linear Accelerator Center	3.0	4.5
Nuclear physics:		
Argonne National Laboratory	.2	.8
Brookhaven National Laboratory	.5	.0
Lawrence Berkeley Laboratory	2.3	1.1
Los Alamos National Laboratory	3.1	1.0
Oak Ridge National Laboratory	.1	1.0

ENVIRONMENT, SAFETY AND HEALTH

Mr. BEVILL. Your budget indicates that $300,000 was transferred to the Assistant Secretary for Environment, Safety and Health. What is the purpose of this transfer?

Dr. TRIVELPIECE. Last September the Secretary unveiled an Environmental Safety and Health initiative to set the Department on a course of action designed to ensure that the operations of the agency continue to be conducted in a safe environmentally sound manner. Accordingly, the Department has transferred $100,000 of FY 1986 Nuclear Physics funds and $200,000 of FY 1986 High Energy Physics funds to assist in undertaking an Environmental Survey, which will look at all facilities on a comprehensive DOE-wide basis.

The Department has also proposed the transfer of an additional $100,000 of FY 1986 Nuclear Physics funds and $200,000 of High Energy Physics funds to the Assistant Secretary for Environment, Safety and Health to support the Department's Atmospheric Release Advisory Capability.

INVENTORY

Mr. BEVILL. Please provide the amounts and type of inventory funding by location included in this appropriation.

Dr. TRIVELPIECE. The Department's FY 1987 General Science and Research budget request includes $3.3 million for special process spares and common use stores inventories. In FY 1987 there are increased needs to provide adequate spares support for the new facilities at Fermilab and SLAC. These facilities require many components that are not off-the-shelf items, but must be custom made in advance if they are to be readily available when a replacement part is needed. We presently plan to provide about $.7 million for special process spares at Fermilab and Stanford Linear Accelerator Center. We also plan to provide about $.8 million for common use stores at Fermilab and Stanford Linear Accelerator Center. Approximately $.3 million is budgeted for common use stores at Brookhaven National Laboratory.

GENERAL SCIENCE PROGRAM DIRECTION

Mr. BEVILL. Please justify the 20 percent increase in General Science Program Direction.

Dr. TRIVELPIECE. The FY 1987 request of $2.5 million reflects a 20 percent increase above the FY 1986 Budget Authority column of the budget. It reflects an increase of less than 5 percent, however, above the actual FY 1986 funding availability. This is due to the fact that the availability of prior year unobligated balances results in an FY 1986 operating level of nearly $2.4 million. These FY 1986 funds are necessary to support the personnel and associated costs of 39 full-time equivalents in the High Energy and Nuclear Physics programs. Salaries and benefits account for approximately 88 percent of the total. The remainder is for staff travel and supplies, materials, and services required by this staff. The increase above the FY 1986 funding availability as just discussed is required to provide for the normal increased personnel costs in FY 1987 which are associated with continuation of this staffing level, such as within-grade and merit increases and associated personnel benefits. In addition, the increased per diem rates resulting from the "Federal Civilian Employee and Contractor Travel Expenses Act of 1985" will also increase the FY 1987 funding

requirements in order to maintain adequate management oversite of the large and complex program activities managed by this staff.

Mr. BEVILL. Please provide the amount of travel funds included in the budget. Please provide this for the contractor facilities as well as Federal employees. Please show separately the foreign travel.

Dr. TRIVELPIECE. The General Science Program Direction budget includes $250,000 for Federal employee travel. It is anticipated that, within that amount, foreign travel for Federal staff will continue at the current level which totaled approximately $20,000 in FY 1985. ER maintains information on contractor travel only as it pertains to foreign travel which was estimated at $2.8 million in FY 1985.

FOREIGN CONTRIBUTIONS

Mr. BEVILL. Please indicate the total financial contribution from foreign sources to the General Science programs.

Mr. TRIVELPIECE. The financial contributions in FY 1986 from foreign sources to collaborative efforts at U.S. high energy physics centers are estimated to include about $10 million from Japan, $3 million from Western Europe, and $2–3 million from other nations. For collaborative efforts at U.S. nuclear physics facilities in FY 1986, we estimate the foreign expenditures to be about $3 million from Western Europe, $2 million from Japan, and a total of $1 million from other countries. It should be noted that these funds are not used for the direct support of facility operations but are for the collaborative experiments involving the equipment and detectors for support of the foreign scientists and some of the detectors used in these experiments.

OUTSTANDING JUNIOR INVESTIGATOR PROGRAM

Dr. BEVILL. Please describe the Outstanding Junior Investigator program and explain the Federal role in financing untenured high energy physicists.

Dr. TRIVELPIECE. The Outstanding Junior Investigator, OJI, program was initiated in 1978 by the Office of Energy Research to assist in the research support of outstanding high energy physicists not yet permanently established in the field. Awards are made in response to research proposals for both experimental and theoretical projects which are subject to the technical review given all proposals and, in addition, to review by a special external peer review panel convened once or twice each year to give advice on the overall and relative merits of OJI proposals. Proposals come directly from sponsoring institutions, which can be universities or laboratories, for named individuals who show high promise in research. The individuals must be untenured but either presently candidates for tenure or expected to become candidates for tenure during the support period. Awards are based on the excellence of the research proposals. Each year the program provides a total of about $300,000 for research grants/contracts to 6–8 new, young investigators with the most outstanding research proposals.

The Federal government is the primary supporter of high energy physics research which is an important component of the nation's basic research effort. It is important to ensure that there is encouragement for the highest qualified young scientists to participate in the nation's basic research effort.

Mr. BEVILL. Please explain the relationship of the Outstanding Junior Investigator program with the University support programs funded in another DOE appropriation.

Dr. TRIVELPIECE. The Outstanding Junior Investigator program is independent of and unrelated to university support programs funded in another DOE appropriation. The awards made under the Outstanding Junior Investigator program are made on the basis of scientific merit of proposals for high energy physics research and are an integral part of the high energy physics research program. In FY 1987, it is planned to provide a total of about $300,000 for grants to 6 to 8 new winners. These awards are made following extensive peer reivew to select those research proposals submitted by junior investigators which have outstanding scientific merit.

FERMILAB COMPUTING FACILITY

Mr. BEVILL. Please describe the impact of a $5 million reduction in the funding for the Fermilab computing facility.

Dr. TRIVELPIECE. The building must be completed before the computing hardware can be delivered. The building was begun in FY 1986 and will be completed using FY 1987 funding. A reduction of $5 million in FY 1987 would reduce the funding available for computing hardware in FY 1987 to about $3.5 million of the total hard-

ware requirement of about $15 million. This would delay the procurement of the main computing engine into FY 1988, and would delay the completion of the project about 1 year with attendant cost increases attributable to schedule stretch out and increases in hardware prices. The greatest impact, which cannot be expressed in dollar terms, will be the unavailability of the planned upgraded computational capabilities necessary for analyzing data generated by the new Tevatron capabilities. The primary physics impact will be on the extraction of results from experiments with the Collider Detector at Fermilab using the world-unique capabilities of the Tevatron collider to investigate an unexplored physics domain.

Mr. BEVILL. What funding is included in the budget for equipment to be used at non-U.S. facilities? In what countries is this equipment manufactured?

Dr. TRIVELPIECE. For FY 1987, approximately $10–11 million in capital equipment funds is planned for use in U.S. collaborative experiments at non-U.S. high energy physics facilities with world-unique capabilities not available in the U.S. Of this amount, $7 million is related to U.S. participation in collaborative experiments at the Large Electron-Positron, LEP, project at CERN; $1 million is of U.S. participation in the AMY experiment at TRISTAN in Japan; $1 million is for U.S. participation in the MACRO experiment at Gran Sasso in Italy; and $1–2 million is for U.S. participation in collaborative experiments at the Hadron-Elektron-Ring-Anlage, HERA, at DESY in West Germany. For nuclear physics research, the estimate for FY 1987 capital equipment funds for experiments outside the U.S. is approximately $1.5 million. This is all associated with experiments at CERN. Most of the equipment for both programs will be manufactured in the U.S., and the U.S. will retain title to equipment acquired with U.S. funds. For the L3 experiment at CERN, there will be a substantial amount of Bismuth-Germanate crystals manufactured in Shanghai, PRC.

Mr. BEVILL. What is the corresponding funds invested by non-U.S. nations in U.S. facilities.

Dr. TRIVELPIECE. For FY 1986, it is expected that about $21–22 million will be invested by non-U.S. nations in U.S. facilities. Of this amount above $12 million is from Japan, $6 million from Western Europe, and $3–4 million from all other countries.

INCREASE IN GENERAL SCIENCE

Mr. BEVILL. Almost all components of the General Science appropriation increase in FY 1987 over FY 1986. In view of the severe limitations on the Federal budget and the reductions in DOE energy programs, please justify the need to increase the budget over inflation in order to maintain U.S. leadership in accelerator technology.

Dr. TRIVELPIECE. The FY 1987 request for General Sciences of $773,400,000 is an increase of about 7 percent above the FY 1986 level of effort prior to Gramm-Rudman-Hollings. It is about 5 percent above the FY 1985 funding appropriation, which is clearly less than inflation over this two-year period. In the high energy physics program, the need for increased funding in FY 1987 is the incremental funding for first operations for research of the Tevatron proton-antiproton collider at Fermilab and of the electron-position linear collider at SLAC. Effective utilization of the new world-class forefront research capabilities provided by these facilities is of highest priority for the high energy physics program and important to get a return from the substantial investment of scientific manpower and Federal funding in these new facilities. In the nuclear physics program, the major needs are the initiation of construction of the Continuous Electron Beam Accelerator Facility, CEBAF, accelerator; first research operation of the heavy ion capability of the Alternating Gradient Synchrotron, AGS, provided by the AGS/Tandem beam transfer line project; and restoration of utilization of existing facilities to about the FY 1985 level. CEBAF will open up a new area for investigation of the ways in which the quark substructure of protons and neutrons influence the behavior and makeup of nuclei and the way that quarks interact while embedded within nuclear matter. CEBAF is the highest priority new capability for the nuclear physics program and an important step in maintaining America's strength in basic nuclear research.

Mr. BEVILL. Please provide a comparison of the operating expenses, beam time and utilization of the LAMPF and Bevalac facilities in FY 1985, FY 1986 and FY 1987.

Dr. TRIVELPIECE. The operations expense and utilization figures for the LAMPF and Bevalac facilities are shown in the table which I would like to insert in the record.

[The information follows:]

[Budget authority amounts in thousands of dollars]

	Fiscal years—		
	Actual (1985)	GRH adjusted (1986)	President's budget (1987)
Bevalac:			
Expenses for operations	$17,426	$16,649	19,690
Beam hours for research	3,353	2,700	3,400
Percent of full utilization	56	45	57
LAMPF:			
Expenses for operations	$39,245	$37,385	$42,920
Beam Hours for Research *	3,325	2,100	2,800
Percent of full utilization	74	47	62

Since LAMPF Supplies many secondary beams simultaneously, the annual totals for experimental hours are about a factor of ten larger than the hours of accelerator operations given in the table.

NUCLEAR PHYSICS FACILITIES

Mr. BEVILL. Please provide a listing and funding in FY 1985, FY 1986 and FY 1987 for all facilities funded by Nuclear Physics. Please briefly describe these facilities and indicate their contribution to Nuclear Physics.

Dr. TRIVELPIECE. I would like to insert in the record tables showing Nuclear Physics fundings by facility and a brief description of these facilities and their contributions to nuclear physics.

[The information follows:]

NUCLEAR PHYSICS EXPENSES FOR FACILITY OPERATIONS

[Budget authority in thousands of dollars]

	Fiscal years—		
	Actual (1985)	GRH adjusted (1986)	President's budget (1987)
National facilities:			
ANL/ATLAS	$2.795	$2,619	$2,970
BNL/Tandem-AGS	1,500	3,193	8,670
LBL/Bevalac	17,426	16,649	19,690
LBL/88-inch Cyclotron	2,044	1,956	2,185
LANL/LAMPF	39,245	37,385	42,920
MIT/Bates	5,675	5,332	6,440
ORNL/Holifield	4,955	4,682	5,185
SLAC/NPAS	1,090	1,459	1,800
University facilities:			
Duke/TUNL	685	610	715
Texas A&M/Cyclotrons	650	622	680
Washington/Tandem-Booster	720	680	805
Yale/Tandem	1,085	1,029	1,270

NUCLEAR PHYSICS FACILITIES

National Facilities	Physical Description	Research Areas
ANL/ATLAS	Superconducting linac injected by 9 MV FN Tandem. Accelerates ions with masses up to 130 AMU to energies of 5 MeV/AMU--lighter ions to 27 MeV/AMU.	High-spin nuclear states, heavy-ion induced resonances, fission and fusion reactions, quasi-elastic and deep inelastic reactions, mass spectrometry.
BNL/Tandem-AGS	Alternating Gradient Synchrotron injected by 20 MV Double MP Tandem. Will accelerate ions with masses up to 32 AMU to energies of 14 GeV/AMU.	Formation of extremely hot, dense nuclear matter not previously available for study.
LBL/Bevalac	Synchrotron (Bevatron) injected by SuperHILAC. Accelerates ions with masses up to 238 AMU to energies of 1 GeV/AMU--lighter ions to 2.1 GeV/AMU.	Nuclear equation of state, production mechanisms of subnuclear particles in nuclear matter, nuclei far from stability, searches for new isotopes.
LBL/88-inch Cyclotron	Accelerates ions with masses up to 100 AMU to energies up to 5 MeV/AMU--lighter ions up to 35 MeV/AMU.	Energy dependence of reaction mechanisms, study of exotic nuclei, nuclei at high angular momentum, nuclear astrophysics.
LANL/LAMPF	800 MeV, high intensity (1 milliampere) proton linac with multiple secondary beams.	Nuclear structure, reaction mechanisms, nucleon-nucleon interactions, weak interactions.
MIT/Bates	Electron linac with recirculator. Accelerates electrons to 750 MeV.	Mean-field theory tests, nuclear dynamics, response functions, production mechanisms.
ORNL/Holifield	25 MV folded Tandem direct beams or with cyclotron booster. Accelerates ions with masses up to 238 AMU to energies of 6 MeV/AMU--lighter ions to 25 MeV/AMU.	Nuclear structure and dynamics under various conditions, fusion, fission, fragmentation.
SLAC/NPAS	Injector for last 5 sectors of SLAC yields 4 GeV electrons.	Elastic and inelastic electron scattering, high momentum transfer studies.

University Facilities	Facility Description	Research Areas
Duke/TUNL	FN Tandem injected by small sector-focused cyclotron to give 32 MeV protons. Tandem alone gives 17 MeV polarized protons or deuterons.	Nuclear resonances, radiative capture reactions, fast neutron scattering cross sections, spin-dependent effects, symmetry-breaking processes, weak interactions.
Texas A&M/Cyclotrons	Sector-focused, variable energy cyclotron accelerates ions with masses up to 40 AMU to energies of 8 MeV/AMU. Superconducting cyclotron will accelerate ions with masses up to 208 AMU to energies of 6MeV/AMU—lighter ions to 80 MeV/AMU.	Parity violation in hadronic weak interactions, masses of exotic nuclei, structure of giant giant resonances, properties of few-nucleon systems.
Washington/Tandem-Booster	Superconducting linac injected by 9MV FN Tandem. Accelerates ions with masses up to 56 AMU to 7 MeV/AMU—lighter ions to 18 MeV/AMU.	Fundamental symmetries in nuclei and atoms, excitation of giant resonances, reaction mechanisms, nuclear astrophysics.
Yale/Tandem	13 MV MP Tandem being upgraded to 22.5 MV Tandem. Will accelerate ions with masses up to 208 AMU to energies of 3 MeV/AMU—lighter ions to 15 MeV/AMU.	Nuclear structure and dynamics, spin-dependent effects, collective and molecular phenomena.

HIGH ENERGY PHYSICS FUNDING

(DOLLARS IN MILLIONS)

	FY 1985	Post GRH FY 1986	FY 1987
A. Operating Expenses			
Fermilab	$120.6	$117.3	$135.9
Research	9.6	9.4	10.3
Facility Operations	83.3	84.5	100.7
Technology	27.7	23.4	24.9
SLAC	78.5	76.1	96.9
Research	11.1	10.8	11.9
Facility Operations	50.8	49.8	68.6
Technology	16.6	15.5	16.4
BNL	62.3	61.7	66.2
Research	7.1	7.0	7.6
Facility Operations	35.9	35.7	38.4
Technology	19.3	19.0	20.2
LBL	17.3	17.1	18.6
Research	8.4	8.5	9.2
Facility Operations	0.7	0.7	0.8
Technology	8.2	7.9	8.6
ANL	6.6	6.2	7.0
Research	4.9	4.8	5.3
Technology	1.7	1.4	1.7
Universities and Other Contracts	83.9	91.5	102.9
Research	65.2	65.8	74.3
Facility Operations	2.0	4.4	4.9
Technology	16.7	21.3	23.7
Total	$369.2	$369.9	$427.5
Research	106.3	106.3	118.6
Facility Operations	172.7	175.1	213.4
Technology	90.2	88.5	95.5

Mr. BEVILL. During the past year you have conducted a fairly extensive scoping of the Superconducting Super Collider (SSC). Please describe the status of the project and the range of total costs of such a program.

Dr. TRIVELPIECE. This past year has seen a great deal of activity including the assembly and testing of many SSC model magnets. This program has been highly successful and allowed selection of a magnet style for the superconducting magnets which is considered the best choice for both technical and overall cost considerations. A detailed Conceptual Design Report for the overall SSC facility based on this magnet design is in the final stages of preparation. This report will have a detailed non-site specific design for the facility capable of achieving the SSC goals. A detailed cost and schedule for the project are part of this report. The new bottoms-up cost estimates by the SSC Central Design Group, CDG, appear generally consistent with those of the Reference Designs Study from two years ago and perhaps somewhat lower. The final numbers are now being rechecked and verified by the CDG and will be available for DOE review in April.

Mr. BEVILL. How much was included in the FY 1985, FY 1986, and FY 1987 budgets for the SSC?

Dr. TRIVELPIECE. The FY 1985 and FY 1986 budgets each had $20 million R&D aimed specifically at the SSC. As stated previously, the FY 1987 activities will depend on the Department's review this spring and summer, and it is considered premature to assign a specific number to SSC R&D in FY 1987.

Mr. BEVILL. Since the FY 1987 funding for High Energy Technology is greater than the FY 1986 level, is the $20 million for SSC included in the FY 1986 appropriation available in FY 1987?

Dr. TRIVELPIECE. The FY 1987 request for high energy technology provides for an overall level of effort below the FY 1985 level and somewhat below the pre-Gramm-Rudman-Hollings FY 1986 level. The direction and emphasis of accelerator R&D activities in FY 1987, especially the work on superconducting accelerator magnets and associated systems, will depend on the results of the Department's review of the SSC this summer. However, we believe that by focusing on the most critical SSC R&D requirements, the FY 1987 funding needs for SSC R&D can be accommodated within the FY 1987 request for the high energy technology subprogram.

Mr. BEVILL. If a decision is made in FY 1986 to proceed with SSC, what funding would be required in FY 1987?

Dr. TRIVELPIECE. The Central Design Group has indicated a need for $30 to $40 million for R&D in FY 1987 to proceed with construction in FY 1988. Although the full amount cannot be accommodated within the FY 1987 request for high energy technology, we believe that by focusing on the most critical SSC requirements, the highest priority FY 1987 needs for SSC R&D could be accommodated within the FY 1987 request.

Mr. BEVILL. If a decision is made in FY 1986 to *not* proceed with SSC, what funding would be required in FY 1987?

Dr. TRIVELPIECE. As indicated earlier, the FY 1987 request for high energy technology permits an overall level of effort accelerator R&D program below the FY 1985 level and near the pre-Gramm-Rudman-Hollings FY 1986 level. It needs to be noted that the U.S. high energy physics program will require some new frontier experimental capability by about the mid-1990's if it is to remain a viable and first rate research effort. Detailed considerations of promising alternative technologies for such forefront experimental capabilities have shown that under all circumstances superconducting magnets will be required. Thus, a substantial level of superconducting magnet R&D needs to be carried out in the program even if the specific focus on the Superconducting Super Collider, SSC, were discontinued. This would make it important also to bring on-going SSC R&D activities to an orderly conclusion in order to obtain the results of these R&D studies and benefit from these investments. The funding required in FY 1987 to responsibly close out some of the ongoing SSC R&D studies on superconducting magnets, cryogenics, accelerator systems, and beam dynamics, and to redirect others, would be near the FY 1986 funding level for SSC R&D activities. It should be recalled that when R&D studies for the SSC were first initiated in FY 1984, this effort was accomplished by redirecting ongoing accelerator efforts within the high energy plysics program, without the appropriation of any additional funds.

Mr. BEVILL. What specific SSC tasks were planned in FY 1986 when the FY 1986 budget was submitted and what specific tasks are now proposed for the $20 million appropriated in FY 1986?

Dr. TRIVELPIECE. There has been no change in tasks planned for SSC R&D in FY 1986 since the FY 1986 budget was submitted. The principal tasks being carried out this year are to optimize design of the selected magnet type, to fabricate full-scale dipole magnet prototypes for systems tests in FY 1987, to produce a Conceptual Design Report with detailed designs, cost estimates and schedules, and to conduct R&D studies on other SSC systems. Prior to the FY 1986 Gramm-Rudman-Hollings reductions, we had considered initiating industrial participation in the superconducting magnet R&D in FY 1986 through redirection of other high energy technology funds.

Mr. BEVILL. Based on current thinking, please give a description of the SSC.

Dr. TRIVELPIECE. The SSC continues to be envisioned as a protonproton collider with 20 TeV per beam and the high interaction rate important for the study of critical phenomena at the highest possible masses. The magnet type selected as optimum for the SSC facility last September with a field of 6.6 Tesla now defines the circumference as about 52 miles. A decision made last fall clusters the experimental areas into two groups, giving a somewhat oval shape to the ring. The injector cascade of accelerators starts with a 600 MeV linac, followed by three booster synchrotrons having top energies of 8, 100, and 1000 GeV, respectively. The collider itself will require a total of 7680 superconducting dipole magnets, each about 17 meters in length, to conduct the 20 TeV protons on their paths around the ring. The Conceptual Design Report will give a very detailed description of the facility.

Mr. BEVILL. If a decision is made to proceed with the project, when do you plan to start actual construction of the project and when do you envision completing the project?

Dr. TRIVELPIECE. The schedule for project start will depend on the outcome of the Departmental review this summer. If we were to proceed with construction in FY 1988, it is anticipated that there would be a relatively slow start in the first year of construction. Construction could be completed in about 7 years with first operation possible in FY 1995.

Mr. BEVILL. What progress has been made with regard to selecting a site for the SSC?

Dr. TRIVELPIECE. In December 1984, the Department announced a plan for site selection to be used at an appropriate time following a decision to proceed. This includes the use of an evaluation committee which the National Academies of Science and Engineering have agreed to establish to select a small number of the very best sites. At the request of the Department, the SSC Central Design Group prepared a site parameters document listing essential and desirable features of the site. This was made available to interested parties in June 1985. No request for SSC site proposals will be issued until the Department has made a commitment to proceed with the project.

Mr. BEVILL. What are the current prospects for non-Federal financial support for SSC?

Dr. TRIVELPIECE. There are two possible sources for non-Federal financial support for the SSC, state (and local) and international. International cooperation is being pursued on several fronts, particularly through the economic Summit process and directly with the Japanese. If the SSC goes ahead, the Japanese have indicated that they want to be associated with it. Translating this into specific agreements will be a complex process, but a start has been made. Clearly, such negotiations can become much more definitive once the U.S. is committed to the project. The possibilities for contributions from states and localities will be better understood once site proposals are received. The Department has not requested SSC site proposals and has no mechanism for monitoring the State activities and intentions. The ad hoc information we have received indicates much interest and a wide range of activity.

EUROPEAN SUPPORT FOR HIGH ENERGY PHYSICS

Mr. BEVILL. Is the European community expanding or contracting its existing commitment to High Energy Physics?

Dr. TRIVELPIECE. The European community is expanding its commitment to high energy physics. Even though the CERN budget is relatively stable, there is substantial growth in a number of the national programs. The European program includes a commitment to construction of two major facilities, each in the billion dollar class. These are the Large Electron-Positron, LEP, project at CERN and the Hadron-Elektron-Ring-Anlage, HERA, at DESY. The new CERN LEP collider is expected to first operate in 1989, and the new DESY HERA collider is expected to first operate in 1990. In addition, there is a substantial new initiative in Italy at the Gran Sasso

underground facility which will house several very large experimental facilities requiring shielding from cosmic ray backgrounds.

Mr. BEVILL. What is the schedule for the first operation for research of the Tevatron proton-antiproton colliding beam at Fermilab?

Dr. TRIVELPIECE. The present plan is to begin cooldown of the Tevatron superconducting magnet accelerator at the beginning of FY 1987. First operation for research is planned to begin in December 1986.

STANFORD LINEAR COLLIDER

Mr. BEVILL. When will you commence operation research at the Stanford Linear Collider?

Dr. TRIVELPIECE. The first physics run with the Stanford Linear Collider is presently scheduled to begin in February 1987.

Mr. BEVILL. Your budget states that the operation of the upgraded Fermilab and SLC will require significant increases in funding in FY 1987. What is the DOE funded staff at these two facilities in FY 1985, FY 1986 and FY 1987?

Mr. TRIVELPIECE. DOE funded staff at Fermi National Accelerator Laboratory (Fermilab) and at Stanford Linear Accelerator Center (SLAC) in FY 1985, FY 1986, and FY 1987 are as follows:

	Fiscal years—		
	Actual 1985	Current 1986	Planned 1987
Fermilab	2,200	2,150	2,160
SLAC	1,990	1,820	1,610

Mr. BEVILL. What other factors beside staffing contribute to the increased funding in FY 1987? Please specify and provide a table showing these costs for FY 1985, FY 1986, and FY 1987 at each location.

Dr. TRIVELPIECE. The total request for high energy physics in FY 1987 is at the same dollar level as that appropriated in FY 1985, resulting in a reduced overall level of effort. There is a shift of emphasis and a redistribution of funding from construction to operation as the major Tevatron and Stanford Linear Collider, SLC, construction programs are completed and these new world-forefront capabilities come into operation. There is no increase in overall program manpower, and indeed the program manpower level in FY 1987 is expected to be about 5 percent less than in FY 1985. Because of the substantial construction activities at Fermilab and SLAC in FY 1986 which required long shutdowns, and because of budgetary pressures, operating levels of the accelerator facilities for research in FY 1986 were very low. The primary category with an increase in funding in FY 1987 is the facility operations subprogram. This is necessary to provide for first operation for research of two world-class facilities, the Tevatron collider and the SLC collider. The increase is due to the costs of the electric power, cryogenics, and klystron replacements required to operate Tevatron and SLC accelerators and detectors, in addition to the transfer of skilled laboratory manpower now supported on the construction projects to the operating budget as Tevatron and SLC come into operation. In FY 1987, the construction funding for the high energy physics program decreases significantly from FY 1985 as Tevatron and SLC are completed. I would like to provide for the record a breakdown of the budget by subprogram at each location and breakdowns of the facility operations increases at Fermilab and SLAC.

[The information follows:]

B. Capital Equipment			
Fermilab	$ 27.5	$ 31.1	$ 30.5
SLAC	9.1	14.6	21.0
BNL	4.5	5.0	5.2
LBL	1.7	1.4	1.6
ANL	1.3	0.8	0.7
Universities & Other	10.7	13.4	14.3
Subtotal Programmatic	$ 54.8	$ 66.3	$ 73.3
BNL Other Cap. Equip.	3.9	3.7	4.2
C. Construction			
AIP	$ 10.0	$ 10.1	$ 11.3
GPP	10.2	10.0	11.2
Tevatron II	12.0	-	-
Tevatron I	21.3	8.2	0.4
SLC	60.5	21.9	1.0
Fermi Computer Upgrade	-	3.0	14.2
AGS Accum./Booster	-	1.9	3.5
	$114.0	$ 55.1	$ 41.7

HIGH ENERGY PHYSICS

FERMILAB FACILITY OPERATIONS INCREMENTAL FUNDING REQUIREMENTS

(B/A IN MILLIONS)

- FY 1986 base (after O-R-H reduction)	$ 84.5
- Cost of living	5.1
- Accelerator startup and operations	10.0
— electric power ($4.9)	
— cryogenic liquids ($3.2)	
— staff replacements (25MY) ($1.5)	
RF tubes ($0.4)	
- Incremental operating costs for CDF detector and experimental hall, and for antiproton source	1.0
- FY 1987 President's budget	$100.7

HIGH ENERGY PHYSICS

SLAC FACILITY OPERATIONS INCREMENTAL FUNDING REQUIREMENTS

(B/A IN MILLIONS)

- FY 1986 base (after G-R-H reduction)		$49.8
- Cost of living (excluding electric power)		2.5
- Incremental power costs *		7.5
-- WAPA rate increase for same usage	($1.3)	
-- Additional power for SLC (higher pulse rate)	($6.2)	
- Klystron replacements * (shorter lifetime due to higher pulse rate operation required by SLC and high infant mortality on first operation of new higher power SLC tubes)		4.8
- Accelerators: spares and incremental maintenance		1.2
- Transfer of needed operating manpower (50 MY) from construction--other construction manpower terminated		2.8
- FY 1987 President's budget		$68.6

* FY 1987 is first year of research operation of SLC. Operation of SLC requires linac operation at 120 pulses per second, increasing the power usage at SLAC and requiring purchase of power from PG&E.

STANFORD LINEAR COLLIDER

Mr. BEVILL. The justification states that a significant cause for the increase in operating at SLC results from an increase in electric power rates from WAPA of 50% from 1985–1987. What is the rate of increase from FY 1986 to FY 1987?

Dr. TRIVELPIECE. The WAPA electric power rate is expected to increase from $24 per megawatt hour in FY 1985 and $32 per megwatt hour in FY 1986 to $37 per megawatt hour in FY 1987; an increase of 16 percent from FY 1986 to FY 1987. In addition, SLC operation requires the linac operating energy to be increased from 33 to 50 GeV and the pulse rate to be increased from 60 to 120 pulses per second. This will drive SLAC's power demand above the WAPA allocation. This will require that a significant amount of power be purchased from Pacific Gas and Electric, PG&E, at an estimated cost of $72 per megawatt hour for FY 1987 where no PG&E power was required in FY 1985 or FY 1986.

Mr. BEVILL. The budget justification indicates that the increased High Energy Physics funding will still require reducing the operation of "other" accelerator capabilities. Please explain and list the facilities and extent of the reduction.

Dr. TRIVELPIECE. In FY 1987, there are major incremental costs required to initiate operation of two new world-forefront facilities; the Tevatron collider at Fermilab and the Stanford Linear Collider. At Fermilab, this includes costs for incremental power and cryogenic fluids to operate the Tevatron and incremental operating costs for the CDF detector, experimental hall, and antiproton source. It should be noted that the antiproton source includes two 8 GeV accelerators, the Accumulator and Debuncher; the antiproton target; and beam transport systems. At SLAC, the increased operating costs include incremental power costs due to increased usage, increased WAPA rates, and the necessity to purchase power from Pacific Gas and Electric; klystron replacements; and transfer of needed operating manpower, 50 MY, for SLC from construction.

In order to accommodate the needs of these new facilities within the funding available in the request it is necessary to reduce operation of the SLAC Positron-Electron Project, PEP, and the Stanford Positron Electron Asymmetric Ring, SPEAR, and the BNL Alternating Gradient Synchrotron, AGS, at BNL below the pre-Gramm-Rudman-Hollings levels of FY 1986 which were the basis for the budget narrative. In addition to these reductions it is also necessary to reduce Tevatron fixed-target operations below FY 1985. The AGS is expected to run 26 weeks in FY 1987 for high energy physics compared to 30 weeks in FY 1986 pre-Gramm-Rudman-Hollings; 24 in post-Gramm-Rudman-Hollings. SPEAR is projected to run for 13 weeks for high energy physics in FY 1987 compared to 14 in FY 1986 post-Gramm-Rudman-Hollings; 16 pre-Gramm-Rudman-Hollings. PEP is projected to run 17 weeks in FY 1987 compared to 20 in FY 1986 post-Gramm-Rudman-Hollings; 22 pre-Gramm-Rudman-Hollings. The Tevatron fixed-target program is projected to run 13 weeks in FY 1987 compared to 30 weeks in 1985. This program did not operate in FY 1986 due to construction-related shutdowns. In FY 1987 the Tevatron can operate in either the fixed target or the colliding beam mode, but not both simultaneously.

FACILITY UTILIZATION

Mr. BEVILL. The budget states the average facility utilization will near the 50% level. Does this represent an increase from FY 1985 and FY 1986? Please provide a detailed table showing operating times.

Dr. TRIVELPIECE. The average facility utilization near the 50% level projected for FY 1987 is less than the actual percentage utilization in FY 1985, but is greater than that expected in FY 1986 after adjustments for Gramm-Rudman-Hollings. FY 1986 is a difficult year to compare with because of the special circumstances relating to construction-related shutdowns at Fermilab and SLAC. It should also be noted that the program in FY 1987 is qualitatively different than that in the FY 1985 or 1986. In FY 1987, the new Tevatron collider and Stanford Linear Collider will be in operation, a more complete set of Tevatron fixed-target capabilities will be available, and there will be no fixed-target experiments at SLAC. Even though the percentage utilization level does not increase, there will be more physics overall, and especially physics in new unexplored domains. I will provide a table for the record giving operating times for the various high energy physics accelerator facilities.

[The information follows:]

HIGH ENERGY PHYSICS ACCELERATOR OPERATION (IN WEEKS)

	Fiscal years—			
	Actual 1985	Projected pre-GRH 1986	Projected post-GRH 1986	Projected 1987
Fermilab:[1]				
Fixed target physics	30			13
Antiproton source studies		20	20	
Collider test		8	2	8
Collider physics		4		13
Physics total	30	4		26
		26		
SLAC:[2]				
Linear accelerator 30 GeV fixed target		8	8	
SPEAR collider (HEP)[3] 3.5 GeV per beam	17	16	14	13
PEP collider 15 GeV per beam	27	22	20	17
SLC collider tests	2	20	18	17
Physics at — 50 GeV per beam				13
Physics average	22	20	17	[4] 15
Brookhaven AGS:				
Neutrino	14	15	13	13
Slow spill	15	9	6	8
Polarized	0	6	5	5
Physics total	29	30	24	[5] 26

[1] The Tevatron starting Fiscal Year 1987 can operate for either fixed target or collider physics, but not both simultaneously.
[2] SLAC physics weeks not additive; the programs usually run simultaneously.
[3] SPEAR also runs for a comparable amount of time dedicated for the synchrotron radiation program.
[4] SLAC Physics average is average of PEP and SLC.
[5] AGS will also run 10 weeks for heavy ion physics in Fiscal Year 1987.

PHYSICS RESEARCH

Mr. BEVILL. Please explain the rationale for the need to increase physics research consistent with accelerator operations increasing.

Dr. TRIVELPIECE. The physics research subprogram supports the research groups which carry out the experiments and use the major experimental facilities at the national laboratories. Thus support of these university and laboratory based users must be at a level commensurate with facility operations. In FY 1987, there will be heavy emphasis on experiments involving the new Tevatron collider and the Stanford Linear Collider. These major new facilities with world-unique research capabilities will operate for research for the first time in FY 1987. Thus some increased support is needed for these research groups to effectively carry out their experiments.

Mr. BEVILL. Do the increased funds for physics research result in additional staffing?

Dr. TRIVELPIECE. There will be no increase in overall staffing. The increased funds are required to meet the demands of the new experiments, which I have already discussed. The FY 1987 request represents about a constant level of effort with the FY 1985 program and the pre-Gramm-Rudman-Hollings level for FY 1986.

Mr. BEVILL. Please provide an analysis of the components of physics research showing the increases.

Dr. TRIVELPIECE. The increase in physics research includes $4.4 million for laboratory groups and $8.1 million for university groups compared to the post-Gramm-Rudman-Hollings FY 1986 funding level. The FY 1987 request maintains a constant level of effort relative to the FY 1985 level and the FY 1986 level prior to Gramm-Rudman-Hollings. The part of this increase above inflation is primarily to enable experimental research groups to participate effectively in experiments at the new facilities. A breakdown of physics research funds by location will be provided for the record.

[The information follows:]

PHYSICS RESEARCH

[Budget authority in millions]

	Fiscal years—		
	1985	1986	1987
Fermilab	$9.6	$9.4	$10.3
SLAC	11.1	10.8	11.9
BNL	7.1	7.0	7.6
LBL	8.4	8.5	9.2
ANL	4.9	4.8	5.3
Universities and other contracts	65.2	65.8	74.3
Total	106.3	106.3	118.6

DETECTORS

Mr. BEVILL. Please show the FY 1985, FY 1986 and FY 1987 funding for Fermilab and SLC detectors.

Dr. TRIVELPIECE. I will provide a table for the record with the requested detector cost data.

[The information follows:]

MAJOR COLLIDER DETECTOR FUNDING

[Dollars in millions]

	Fiscal years—		
	1985	1986	1987
Fermilab:			
CDF	$11.6	$9.0	[1] $3.5
D-Zero	0.6	7.5	12.5
SLAC:			
SLD	2.1	7.0	14.5
Mark II	3.5	2.6	

[1] Upgrade.

Mr. BEVILL. What is the anticipated effect on the "base" capital equipment program as the new detectors are financed?

Dr. TRIVELPIECE. The so-called "base" Capital Equipment program, which can be described as all of the other instrumentation and equipment needs other than the large detectors, has been cut back as far as prudent for overall program health and is being held roughly stable now as we proceed with fabrication of the large detectors. The capital equipment add-on provided by the Congress in FY 1986 was a major factor in allowing the major new collider detectors to proceed without significant damage to the base program

Mr. BEVILL. Please show the schedule for the completion of Fermilab and SLC detectors and provide the total estimated costs.

Dr. TRIVELPIECE. I will provide a table for the record with the requested information.

[The information follows:]

Fermilab and SLC detectors

[Dollars in Millions]

Fermilab collider detectors:	
CDF: Scheduled completion 4th quarter fiscal year 1986:	
DOE	$40.6
NSF	2.0
Japan	12.5
Italy	5.0
Total estimated cost	60.1

D-Zero: Scheduled completion 4th quarter fiscal year 1989:	
DOE	50.1
NSF	4.2
France (Saclay)	1.2
Total estimated cost	55.5
SLAC SLC Detectors:	
MKII upgrade: Scheduled completion 1st quarter fiscal year 1987:	
Total estimated cost: DOE	11.3
SLD: Scheduled completion 4th quarter fiscal year 1989:	
DOE	$49.2
NSF	1.1
Canada	1.5
Italy	1.3
Total estimated cost	53.1

HIGH ENERGY PHYSICS FACILITIES

Mr. BEVILL. Please provide a list of all funding in FY 1985, FY 1986 and FY 1987 for all facilities funded by Higher Energy Physics. Please briefly describe these facilities and indicate their contribution to High Energy Physics.

Dr. TRIVELPIECE. I would like to insert in the record the requested facility descriptions and funding information.

[The information follows:]

STANFORD LINEAR ACCELERATOR CENTER HEP FACILITIES SLAC BUDGET

[Budget authority in thousands of dollars]

	Fiscal years—		
	1985	1986	1987
Total	$152,296	$116,853	$123,876
Operating	78,526	76,110	96,900
Physics research	11,106	10,818	11,900
Accelerator operations	27,700	27,285	40,700
Experimental facility operations	23,135	22,498	27,900
Accelerator R&D	10,135	8,500	8,600
Experimental facility R&D	6,450	7,009	7,800
Equipment	9,070	14,552	21,000
Construction	64,700	26,233	5,976
Accelerator improvement projects	2,700	2,681	3,100
General plant projects	1,500	1,628	1,900
Stanford linear collider	60,500	21,924	976

The two-mile long linear accelerator (linac) can produce intense beams of electrons at energies up to 32 GeV, or of positrons with energies up to 20 GeV. Electrons and positrons from the linac have been used for fixed target experiments to probe the ultimate structure of matter in ways that reveal details different than any other probe. The linac is also used as the injector for the storage rings, the Positron-Electron Project (PEP) and Stanford Positron Electron Asymmetric Ring (SPEAR). The linac's energy will be increased from 32 GeV to 50 GeV for both electrons and positrons by early FY 1987. It will then serve as the injector for SLC as well as for PEP and SPEAR. Major physics contributions from the fixed-target experiments at the linac include the discovery of parton substructure, the tau lepton, and precision measurements of deep inelastic scattering.

The Stanford Linear Collider (SLC), presently under construction and scheduled for completion in early FY 1987, is an experimental accelerator intended to develop the technology and to test key technical issues of the linear collider concept as a potentially cost-effective approach to high luminosity, very high energy electron-positron collisions. The SLC will also provide a world forefront research capability. Once in operation it will be a source of electron-positron collisions at energies up to

100 GeV center-of-mass energy and provide the capability for producing copious quantities of Z particles, the study of which has very high physics priority.

The Mark II Magnetic Detector previously used for several years in experiments at PEP, and before that at SPEAR, is being upgraded for use as the detector for the first round of high energy physics experiments at the SLC; the upgraded detector is planned to be ready for experimental use at SLC as soon as the high energy electron-positron collisions become available for study; this is expected to occur in the first quarter of FY 1987.

The Stanford Linear Detector (SLD) is a world-competitive second generation detector for the SLC, with good electromagnetic and hadronic calorimetry over the full solid angle, with high resolution measurement of secondary vertices, with full instrumental capability over the complete solid angle, and with good particle identification over a wide range of momentum. The SLD detector will measure the energy of charged particles with strong magnetic fields and of all particles (except neutrinos) with massive calorimeters. It is planned to begin experimental use of the SLD detector in FY 1989.

The Position Electron Project (PEP) is a storage ring which uses beams injected by the SLAC Linac for studies of 30 GeV electron-positron interactions using intersecting beams of 15 GeV electrons and 15 GeV positrons. The PEP luminosity is being substantially upgraded as is the Time Project Chamber detector which will be the primary detector for future PEP experiments. Major physics contributions of PEP have dealt with production, lifetimes and fragmentation of heavy quarks and heavy quarks states.

The Stanford Positron Electron Asymmetric Ring (SPEAR) is a storage ring which uses beams injected by the SLAC Linac for studies of electron-positron collisions in the energy range 3–7 GeV using intersecting beams of 1.5–3.5 GeV electrons and 1.5–3.5 GeV positrons. SPEAR is used 50% of its running time for high energy physics research with SLAC's Mark III Magnetic Detector and 50% of the time by the Stanford Synchrotron Radiation Laboratory for synchrotron radiation research during which time the incremental operating costs are supported by DOE's Division of Basic Energy Sciences. Major contributions of SPEAR have included the co-discovery of the psi/J particle and detailed study of the psi family of particles.

Since FY 1985, the SLAC Linac can also be operated at low energies with a special off-axis injector for nuclear physics research (supported by DOE's Division of Nuclear Physics) and simultaneously for synchrotron radiation research at SPEAR.

BROOKHAVEN NATIONAL LABORATORY HEP FACILITIES BNL BUDGET

[Budget authority in thousands of dollars]

	Fiscal years—		
	1985	1986	1987
Total	$74,867	$75,990	$83,400
Operating	62,270	61,655	66,200
Physics research	7,100	6,989	7,600
Accelerator operations	17,800	17,999	19,500
Experimental facility operations	18,065	17,711	18,900
Accelerator R&D	18,805	16,795	17,400
Experimental facility R&D	500	2,161	2,800
Equipment	4,497	4,978	5,200
Construction	7,700	9,478	12,000
Accelerator improvement projects	2,000	2,106	2,500
General plant projects	5,700	5,457	6,000
Alternating gradient			
Synchrotron accumulator/booster	0	1,915	3,500

The Alternating Gradient Synchrotron (AGS) provides protons for fixed-target experiments at energies up to 33 GeV, using a variety of secondary beams. The world-unique capability to accelerate polarized protons to high energies in the Alternating Gradient Synchrotron (AGS) has been added recently. A link to the Tandem Van de Graaff is being established in FY 1986 to provide the capability to also accelerate medium weight heavy ions.

The Accumulator/Booster (a 1 GeV synchrotron) is being constructed (completion is planned for FY 1989). The objectives of the Accumulator/Booster project are as follows: to increase proton beam intensity by a factor of 4; to increase the polarized beam intensity by a factor of 20; and to provide the capability to fully strip heavy ions up to mass 200, allowing these heavier ions to be accelerated in the AGS (the present limit is mass 32).

Current research at the AGS focuses highest priority on the study of neutrino interactions and the study of certain rare decay modes of the K meson; other experiments involve the study of interactions of protons, pions, kaons, etc., with target nuclei. Major contributions to physics have included the discovery of the muon neutrino, the omega particle, CP violation, and co-discovery of the psi-J particle.

FERMI NATIONAL ACCELERATOR LABORATORY HEP FACILITIES FERMILAB BUDGET

[Budget authority in thousand of dollars]

	Fiscal years—		
	1985	1986	1987
Total	$191,393	$169,719	$190,124
Operating	120,606	117,278	135,900
Physics research	9,603	9,382	10,300
Accelerator operations	49,548	49,783	60,700
Experimental facility operations	33,720	34,753	40,000
Accelerator R&D	19,535	15,360	16,200
Experimental facility R&D	8,200	8,000	8,700
Equipment	27,540	31,115	30,500
Construction	41,600	19,338	23,724
Accelerator improvement projects	5,300	5,265	5,900
General plant projects	3,000	2,872	3,300
Tevatron I	21,300	8,233	367
Tevatron II	12,000	0	0
Computing facility upgrade	0	2,968	14,157

The Fermilab Proton Synchrotron is a conventional magnet synchrotron which provided, from 1972 through 1983, protons at 400 GeV, twice the original design energy, and various secondary particle beams from fixed targets. It has subsequently been used as a 150 GeV injector into the new superconducting magnet synchrotron which upgraded the facility.

The Energy Saver project provided a ring of over 1000 superconducting magnets which operate at reduced electric power consumption and provide the capability for 500 GeV extracted beam and 800 GeV internal beams. The superconducting magnet accelerator is now operated routinely as part of the overall Fermilab Tevatron capability. Tevatron I is an upgrade to reach approximately 1000 GeV acceleration capability, to provide an antiproton beam source and to allow the storage of protons and antiprotons simultaneously. When the two beam collides head-on, this will provide up to 2000 GeV in reaction energy to open up a new era of important research opportunities at the highest energies ever made available for laboratory physics experimentation. The Tevatron I collider was successfully tested at 1600 GeV reaction energy in October 1985; operation for high energy physics research is scheduled to begin in early FY 1987.

The Tevatron II project, to be completed in FY 1986, provides the necessary facilities for a 1000 GeV fixed target experimental program in existing experimental areas to fully exploit the higher energy of the superconducting accelerator complex now referred to as "The Tevatron." Tevatron II provides a unique opportunity for producing secondary particle beams at higher energies and intensities than anywhere else in the world. There are 4 new secondary beams and 8 other upgrade beams; the 12 can be run simultaneously.

The Collider Detector at Fermilab (CDF) is a versatile research detector capable of recording the results of antiproton-proton collisions at reaction energies up to 2000 GeV. It will be installed in the first collision hall and be available to operate for physics research at the time of the Tevatron collider turn-on. CDF is capable of detecting hundreds of simultaneously created particles, and separately identifying pro-

tons, electrons, muons, and hadrons. CDF measures energies of charged particles with strong magnetic fields and of all particles (except neutrinos) with massive calorimeters. The CDF detector had a successful preliminary test run in the fall of 1985, and its first use for high energy physics reserch is planned for late 1986.

The D-Zero Detector at Fermilab (DO) will provide detection capabilities which are complementary to those of the CDF detector, which effectively doubles Tevatron collider physics utilization by operating simultaneously. It will be installed in the second collision hall which will not be available at turn-on. It is planned to begin experimental use of the DO detector in FY 1989. The DO detector is optimized for accurate measurements of energies of electrons, muons, and jets of hadrons. It has no magnetic fields; particle energies are measured with calorimeters only. High resolution calorimetry will allow excellent identification of missing energy in an interaction. The DO detector has very complete solid angle coverage.

AGS ACCUMULATOR/BOOSTER

Mr. BEVILL. Please describe the AGS Accumulator/Booster at Brookhaven and the plans for the potential use of the accelerator ring.

Dr. TRIVELPIECE. The AGS Accumulator/Booster will be a conventional synchrotron with a maximum energy, for protons, of 1 GeV. It is to be situated between the existing 200 MeV linac and the AGS itself. The AGS has three modes of operation: with ordinary protons, polarized protons, and heavy ions, which will be injected into the AGS from the Tandem/AGS transfer line being commissioned during FY 1986. The Accumulator/Booster will be extremely beneficial to the research program in all three modes of operation.

For operation with ordinary protons, the Accumulator/Booster will increase the intensity of the AGS beams by a factor of 4. For operation with polarized protons, the Accumulator/Booster will increase the AGS beam intensity by a factor of about 20. For operation with heavy ions, the Accumulator/Booster will extend the capability of the AGS to accelerate heavy ions, to 11-14 GeV/AMU, from the present mass limit of sulphur ions, mass 32, to gold ions, mass 197. For the longer range future, the nuclear physics program is considering construction of a Relativistic Heavy Ion Collider, RHIC, at BNL. The AGS Accumulator/Booster could serve as an injector for RHIC.

ACCELERATOR IMPROVEMENTS

Mr. BEVILL. Please justify the 15% in accelerator improvements and General Plant projects.

Dr. TRIVELPIECE. The accelerator improvement projects request of $11.5 million in FY 1987 represents a 3 percent increase from the FY 1985 level of effort and 4 percent from the FY 1986 budget before the Gramm-Rudman-Hollings adjusted numbers. The general plant projects request of $11.2 million in FY 1987 represents a constant level of effort relative to FY 1985 and a 2 percent increase for the FY 1986 level prior to the Gramm-Rudman-Hollings adjustments.

The modest increases in the accelerator improvements and general plant projects requests are based on anticipated greater needs at Fermilab and SLAC as major new Tevatron facilities and the Stanford Linear Collider come into operation in FY 1987. As with all advanced accelerator facilities for basic research, accelerator improvement project funds are essential for improvements in operating effectiveness and reliability and to permit response to the immediate needs of the physics research program on a time scale shorter than permitted by the normal budget process. The general plant project funds provide a similar capability in the area of laboratory plant projects.

CONTINUOUS ELECTRON BEAM ACCELERATOR FACILITY

Mr. BEVILL. Please describe the goals and objectives of the Continuous Electron Beam Accelerator Facility.

Dr. TRIVELPIECE. The Continuous Electron Beam Accelerator Facility (CEBAF) will be a high-intensity, CW electron accelerator for nuclear physics. Its principal scientific goal is to understand the quark structure, behavior, and clustering of individual nucleons in the nuclear medium, and simultaneously to understand the forces governing this behavior. To achieve this goal, the mission of CEBAF is to design, build, and operate a world-class electron accelerator facility.

The study of nuclear structure with electromagnetic probes—and, indeed with other probes as well—promises to be a fertile field of science far into the future. The nuclear many-body system has many important aspects and many separate frontiers

while at the same time retaining a fundamental unity. If one asks how to describe the nucleus in terms of the behavior of its constituents, the answer changes with the spatial resolution of the probe. At distances greater than the size of the proton, which can be resolved with electron beams of a few hundred MeV, the familiar picture of neutrons and protons (nucleons) undergoing individual and collective motion in the nucleus emerges. With somewhat higher energies, approaching 1 GeV, the contributions of mesons and nuclear excited states to the electromagnetic structure of the nucleus can become important. As the energy is increased still further, distances small compared to the size of the nucleon itself become accessible and a more explicit account must be taken of the fundamental structure of nucleons as composites of colored quarks interacting through gluon exchange. At this spatial resolution observable effects arising from the overlap of extended nucleons within the nucleus, and the physics of confinement becomes relevant.

In broad general terms, the principal scientific objective of CEBAF is to study the extent to which individual nucleons change their size, shape, and quark structure in the nuclear medium, to study how nucleons cluster in the nuclear medium, and to study the force which binds the quarks into nucleons and nuclei at distances where this force is strong and the confinement mechanism is important. Specific programs include the following:

1. Single particle densities through the (e,e'N) reaction;
2. Two particle correlations by the (e,e'2N) reaction;
3. Photo- and electro-production of excited baryon resonances;
4. Hypernuclei by the (e,e'K) reaction; and
5. The neutron charge form factor, and the separation of the deuteron charge and quadrupole form factors using polarization techniques.

Mr. BEVILL. Please describe the priority placed on this facility and describe the justification for this priority.

Dr. TRIVELPIECE. After almost a decade of planning and study by the nuclear physics community, the DOE/NSF Nuclear Science Advisory Committee has identified and reaffirms this project as the highest priority facility in nuclear physics. Throughout the past decade electromagnetic interactions have been consistently identified as a powerful and uniquely clean means of addressing a broad range of fundamental open questions in nuclear physics. The Report of the NSAC Ad Hoc Subcommittee on a 4 GeV CW Electron Accelerator for Nuclear Physics (September 1984) enumerates the main elements of a structured plan for electromagnetic physics especially in the leading frontier area of the interface between nuclear phenomena and the strong interaction and its characterization in the framework of quarks and gluons. With new electromagnetic probes nuclear physics will deal with the important questions concerning nucleons, nucleon resonances and mesons in nuclei in a broad array of experiments ranging from the exploration of deep-hole states in nuclei to the production and propagation of pions, kaons and deltas in the nuclear medium. For the important issue of nucleon substructure—to what extent and under what circumstances the nucleus should be viewed in terms of quarks and gluons rather than in terms of nucleons and mesons, the scientific interest rests in the hadronic meansurements (excited nucleons for example) and in the questions pertaining to the confinement of quarks in nucleons and mesons.

Mr. BEVILL. Please describe the improvements in design that have been incorporated in this facility.

Dr. TRIVELPIECE. The original CEBAF design included a traveling-wave, room-temperature recirculated linac feeding a pulse stretcher ring meeting the objective of a 0.5–4.0 GeV machine capable of delivering 200 microamperes at high duty factor. Recent advancement in superconducting radio-frequency cavity technology has permitted a substantial improvement in the design. The present design incorporates this new superconducting technology for the accelerating structures eliminating the need for the stretcher ring. This improvement offers improved beam quality, a large reduction in annual operating costs, reduced risk in the area of klystron development, and more reliable and flexible operation.

AGS HEAVY ION RESEARCH PROGRAM

Mr. BEVILL. Please describe the AGS heavy ion research program.

Dr. TRIVELPIECE. The emphasis in the heavy ion research program is on the study of nuclear matter at the highest possible baryon density and temperature. The new high energy heavy ion beams from the AGS will collide with massive nuclei at rest in the laboratory to produce hot, dense nuclear matter. At AGS energies, the beam ion will completely stop in the target nucleus, providing the maximum experimentally achievable nuclear densities. At higher energies, such as proposed for RHIC,

the nuclei pass through each other, leaving a region of very high energy density, but very low mass density. These two different approaches provide two different ways of relaxing the confinement conditions which prevent the quarks from escaping from their nucleonic bags. Three major experiments have been approved.

FACILITY UTILIZATION RATE

Mr. BEVILL. The budget indicates that in addition to $10 million for inflation, $8.2 million is required to bring facility operations to 55% utilization. What was the utilization rate in FY 1985 and FY 1986?

Dr. TRIVELPIECE. The average facility utilization rate was 52% in FY 1985 and is expected to be 47% in FY 1986.

Mr. BEVILL. Why is it appropriate for the Nuclear Physics facility utilization rate to be established at 55% and the High Energy Physics facility utilization at 50%?

Dr. TRIVELPIECE. Facility utilization is but one component of the High Energy and Nuclear Physics programs. Each program must strive to achieve a program balance appropriate to the particular circumstances of the program and the overall funding available to the program in a given year. The situation in high energy, physics, bringing into operation two major new facilities with large incremental operating costs requirements and continuing major detector efforts, lead to an overall utilization percentage of 50% with the funding available. The Nuclear Program will be a highly efficient and balanced program at 55% utilization and will make effective use of its existing facilities. A utilization rate of 55% will be especially beneficial to the research output from those facilities that have recently been upgraded to permit emerging scientific questions to be addressed.

UNIVERSITY RESEARCH

Mr. BEVILL. Please explain the need to "provide the university component of research at 25% of operating expenses".

Dr. TRIVELPIECE. A large fraction of the use of national facilities is by research programs based at universities. Therefore, to maintain this important component of facility utilizations the manpower and instrumentation provided by university scientists must be continued at a level commensurate with facility operations.

Mr. BEVILL. What was the percentage in FY 1985 and FY 1986?

Dr. TRIVELPIECE. The percentage in both years was 25%.

BASIC ENERGY SCIENCES

Mr. BEVILL. The FY 1987 budget request for basic energy sciences includes a proposal for four research facilities: a 1-2 GeV Synchrotron Radiation Source—Lawrence Berkeley Laboratory, a 6 GeV Synchrotron Radiation Source—Argonne National Laboratory, an Advanced Steady State Research Reactor—Oak Ridge National Laboratory; and a Relativistic Heavy Ion Collider—Brookhaven National Laboratory.

Explain to the Committee the requirement for each facility, why each is proposed to be sited where they are and what peer review of each was done.

Dr. TRIVELPIECE. The first three facilities fall within the Materials Sciences subprogram of Basic Energy Sciences: a 1-2 GeV Synchrotron Radiation Source—Lawrence Berkeley Laboratory; a 6 GeV Synchrotron Radiation Source—Argonne National Laboratory, and an Advanced Steady State Research Reactor—Oak Ridge National Laboratory. The need and importance of these facilities to the Department and the Nation were recommended by the National Research Council in their report on Major Facilities for Materials Research and Related Disciplines and the Energy Research Advisory Board reviewed and endorsed this report. These facilities will provide the Nation with advanced probes to characterize the structure and properties of materials. With these facilities, the materials sciences and related disciplines will be able to maintain forefront research activities in the areas of photon and neutron scattering for several decades. The decision process which resulted in these sites being selected for these particular facilities involved DOE management reviewing the capabilities, desires, interests, previous experience and balance among the various possible DOE sites. The Lawrence Berkeley Laboratory already had designed and DOE had requested funding from Congress for an LBL facility in the energy range 1-2 GeV. The Oak Ridge National Laboratory has been pursuing the advanced reactor concept as a replacement for their successful, but 20-year old research reactor, the High Flux Isotope Reactor. Argonne National Laboratory has been developing their concept of a 6 GeV facility since the Planning Study for Ad-

vanced Synchrotron Radiation Facilities first recommended such a facility in early 1984 and is a logical location for such an interactive facility.

The fourth facility, the Relativistic Heavy Ion Collider (RHIC), Brookhaven National Laboratory is included in the Nuclear Physics budget request. The Nuclear Science Advisory Committee's (NSAC) "Long Range Plan for Nuclear Science," of 1983 identified a relativistic heavy ion collider, following CEBAF, as the next highest priority new scientific opportunity within the purview of nuclear physics. The major research direction of RHIC will be in the formation and examination of a quark-gluon plasma, a new state of nuclear matter which hitherto has prevailed only in the very early instance of the creation of the universe. Brookhaven National Laboratory presented RHIC technical and scientific capabilities to NSAC in April and October 1984 and February 1985. In addition to extensive internal reviews, BNL held a workshop on Quark Matter Science in May 1985, attended by over 100 physicists wishing to contribute to the preparation of the RHIC facility and experimental apparatus. The DOE is preparing for extensive scientific and technical reviews of RHIC in the spring and summer of 1986.

Since each of these facilities requires considerable staff and effort to develop, considering the work loads at other laboratories, it is appropriate that this decision be made by DOE management. The DOE management decision process also considered the admonition from ERAB not to start another laboratory, the recommendations from several committees to begin the process of planning for new facilities as soon as possible, the need to plan for possible use of these facilities for defense purposes including classified research, and the recommendation from the Packard Committee on Federal Laboratories of the need to revitalize the Federal laboratories.

NEW INITIATIVES

Mr. BEVILL. What new initiatives other than these facilities are proposed in the FY 1987 budget?

Dr. TRIVELPIECE. There is another project proposed in the Basic Energy Sciences budget for FY 1987. The project is the Neutron Scattering Experimental Hall, Los Alamos National Laboratory, which was initiated by Congressional direction in the Atomic Energy Defense Appropriations in FY 1986 with instructions that future appropriations were to be requested in the Energy Supply Appropriation.

Mr. BEVILL. Provide a list of the 1,200 projects funded in BES, the FY 1985, 1986 and 1987 funding level for each and where each is conducted.

Dr. TRIVELPIECE. Each year the Basic Energy Sciences program prepares for each subprogram a description, funding, and the name of the institution and investigator for all of the projects supported by the subprogram. These summaries have been published for FY 1985, and I would like to have this information inserted for the record. What I would like to provide the Committee for FY 1986 and FY 1987 is the proposed distribution of funding by type of institution as many of the decisions on specific projects are still under review and the comparable information published form is not readily available.

[The information follows:]

[CLERK'S NOTE: The material provided by the Department was unresponsive to the Committee's question and was neither descriptive of the 1,200 projects referred to in the justification material nor informative in terms of prior year expenditures, requested for FY 1987, or purpose, intent and planned funding use's for FY 1987.]

UNIVERSITY TRAINING

Mr. BEVILL. How many people are educated and trained at universities and colleges by these programs annually?

Dr. TRIVELPIECE. Basic Energy Sciences funds research at universities which is carried out to a large extent within the framework of graduate student thesis research projects. About 500 Doctoral and Master's degrees each year are granted as a result of the facilities equipment and support provided through BES to colleges and universities. In addition, research supported at both LBL and Ames Laboratory, colocated with university campuses, results in the graduation of more than 150 Doctoral and Master's level scientists and engineers annually.

Mr. BEVILL. How much is requested in FY 1987 for training and education by DOE by program?

Dr. TRIVELPIECE. While the Basic Energy Sciences does not specifically provide funding for training and education, each of the subprograms do provide funding for university research which indirectly leads to the training of students. This also applies to the research undertaken in the Magnetic Fusion, Biological and Environmental Research, and the High Energy and Nuclear Physics programs. The only

program within the Office of Energy Research which provides direct funding for students is the University Research Support Program and $8,600,000 is requested in the FY 1987 budget for this purpose.

Mr. BEVILL. Discuss BES-funded university research and industry research and indicate the funding request for FY 1987 for each.

Dr. TRIVELPIECE. The Basic Energy Sciences program, in carrying out its long-range energy-related basic research mission, supports researchers and research organizations that are the most capable of conducting such research. These organizations normally do not include industry. On the other hand, in formulating our programs and indentifying those areas most likely to yield knowledge and information contributing towards BES' long term mission, industrial research plays an important role. Also, active efforts are made to convey the results of our research to the industrial sector of our economy. The BES funding for university research for FY 1987 is estimated at about $105 million. The BES funding for industry research is estimated at $4.7 million. Much of it is under the Advanced Energy Projects subprogram. In addition, about $4.7 million dollars will be set aside from the BES budget for the congressionally mandated Small Business Innovation Research activity; all of it will be used in support of researchers employed by small businesses.

FUNDING BY LABORATORY

Mr. BEVILL. Please provide a distribution of the FY 1985, FY 1986, and FY 1987 budget by laboratory.

Dr. TRIVELPIECE. I will be happy to provide that information for the record.

[The information follows:]

BASIC ENERGY SCIENCES LABORATORY FUNDING

[Dollars in thousands]

	Fiscal years—		
	1985	1986	1987
Operating expenses:			
Ames Laboratory	$11,330	$10,628	$11,494
Argonne National Laboratory	38,488	43,317	45,246
Brookhaven National Laboratory	46,051	45,728	51,640
Idaho National Engineering Laboratory	2,586	2,468	2,557
Lawrence Berkeley Laboratory	29,276	27,069	29,964
Lawrence Linermore National Laboratory	10,930	10,340	13,676
Los Alamos National Laboratory	12,999	10,810	13,589
Oak Ridge National Laboratory	51,726	51,739	58,506
Pacific Northwest Laboratory	4,733	3,784	3,700
Sandia National Laboratories	13,485	13,804	14,731
Subtotal operating expenses	221,604	219,687	245,103
Capital equipment:			
Ames Laboratory	1,315	1,086	1,306
Argonne National Laboratory	7,342	5,941	7,572
Brookhaven National Laboratory	3,680	3,559	3,885
Idaho National Engineering Laboratory	139	163	116
Lawrence Berkeley Laboratory	4,751	2,850	3,774
Lawrence Livermore National Laboratory	1,460	728	995
Los Alamos National Laboratory	1,746	1,319	1,427
Oak Ridge National Laboratory	5,727	4,425	5,022
Pacific Northwest Laboratory	567	711	484
Sandia National Laboratories	1,555	1,499	1,524
Subtotal capital equipment	28,282	22,281	26,105
Construction:			
Ames Laboratory	500	577	728
Argonne National Laboratory	3,200	2,886	3,000
Brookhaven National Laboratory	9,100	8,655	5,055
Lawrence Berkeley Laboratory	9,290	11,008	12,060
Los Alamos National Laboratory	0	0	5,000
Oak Ridge National Laboratory	500	1,155	300

BASIC ENERGY SCIENCES LABORATORY FUNDING—Continued

[Dollars in thousands]

	Fiscal years—		
	1985	1986	1987
Sandia National Laboratories	100	289	300
Subtotal construction	22,690	24,570	26,443
Total Laboratories	272,576	266,538	297,651

UNIVERSITY RESEARCH INITIATIVES

Mr. BEVILL. What is the status of each of the university research initiatives included in the FY 1986 Appropriation Act?

Dr. TRIVELPIECE. As you know, funds for these initiatives were proposed to be deferred and are now being converted to rescissions. I would like to insert in the record a status summary of each of the university initiatives included in the Basic Energy Sciences budget in FY 1986.

[The information follows:]

Status of university projects

Project	*Status*
Columbia University—Center for Chemical Research.	Havemeyer Addition under Construction: Foundations completed, structural steel erection in progress. Exterior wall and Interior finished work bid and contracts awarded. Mechanical and Electrical work bids due in late March. Laboratory equipment work to be released for bids in late March. Haveneyer Renovation: Mechanical and Electrical Work bids due in late March. Chandler Renovation: Approval by New York City of Fire Protection System design is expected in March. Electrical System work progresses slowly due to coordination problems with Consolidated Edison involving equipment shop drawings.
Brown University—Center for Information Technology.	An Architect Enigineer firm has been selected to design the center and is currently working on the conceptual design. A Construction Manager has also been selected and will form part of this project team.
University of Alabama—Energy and Mineral Research Center.	Design is in Title II phase. DOE Office of Energy Research and Chicago Operations Office conducted a site visit and validation review of the project design documents on January 15, 1986. A NEPA Review by the Chicago Operations Office has been completed with a determination that the project will present no significant impact to the environment.
Atlanta University—Graduate Research Center for Science and Technology.	Conceptual Design is completed and is being reviewed by the Chicago Operations Office.

Status of university projects—Continued

Project	*Status*
Tulane University—Center, for Energy and Biotechnology.	Conceptual Design is being reviewed by the Chicago Operations Office. A review of the environmental documents is in progress by the Chicago Operations Office with a determination expected by late March.
University of Oregon—Science Facility.	Title I design was essentially completed in January. A NEPA Review by the Chicago Operations Office has been completed with a determination that the project will present no significant impact to the environment.

CENTER FOR ADVANCED MATERIALS

Mr. BEVILL. What is the status of the Center for Advanced Materials?

Dr. TRIVELPIECE. The status of the Center for Advanced Materials is that the construction project is on schedule and proceeding well and the research programs, although smaller at this point than originally envisaged are making effective progress. The Center, when completed will consist of two buildings, the Surface Science and Catalysis Laboratory (SSCL) and the Advanced Materials Laboratory (AML). The SSCL is in the construction phase and the AML is completely designed and full construction will begin soon. Until the new laboratories are completed, the approximately $3 million research program is proceeding in space available elsewhere at LBL. The research topics underway are: catalysis, electronic materials, instruments and sensors, ceramic/metal interfaces, polymers and composites and light alloys. In addition to construction and scientific progress, progress is being made to attract students and industrial personnel to participate in CAM. About 60 students are participating in CAM and CAM workshops have attracted many participants from industry and academia. There have also been 6 visitors from industry and 65 gifts/contracts from industry even in this short incubation period.

FUNDING FOR GPP AND GPE

Mr. BEVILL. Please provide the historical funding for FY 1985, FY 1986, and FY 1987 for the GPP and GPE programs supported by OER. Provide this information by laboratory.

Dr. TRIVELPIECE. I will be happy to provide this information for the record.

[The information follows:]

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
SUMMARY OF GENERAL PLANT PROJECTS
(In Thousands of Dollars)

OFFICE OF ENERGY RESEARCH
ENERGY SUPPLY R&D
BASIC ENERGY SCIENCES

	FY 1985 Actual			FY 1986 Estimate			FY 1987 Request	
	B/A	OBS	B/O	B/A	OBS	B/O	B/A	B/O
Contractors								
Multi-Program Laboratories								
Argonne National Laboratories...	$ 3,000	$ 3,000	$ 1,607	$ 2,886	$ 2,886	$ 2,210	$ 3,000	$ 2,620
Ames Laboratory.....	500	500	384	577	577	440	600	500
Sandia National Laboratories....	100	100	100	289	289	225	300	200
Subtotal.....	3,600	3,600	2,091	3,752	3,752	2,875	3,900	3,320
Other Contractors								
Notre Dame Radiation Laboratory.	50	50	0	29	29	29	30	30
Stanford Synchrotron Rad. Lab. .	100	100	91	96	96	96	150	150
Subtotal.....	150	150	91	125	125	125	180	180
Total, General Plant Projects.....	$ 3,750	$ 3,750	$ 2,182	$ 3,877	$ 3,877	$ 3,000	$ 4,080	$ 3,500

MAGNETIC FUSION ENERGY

	FY 1985 Actual			FY 1986 Estimate			FY 1987 Request	
	B/A	OBS	B/O	B/A	OBS	B/O	B/A	B/O
Contractors								
Multi-Program Laboratories								
Lawrence Livermore National Laboratory	$ 1,000	$ 1,000	$ 1,175	$ 289	$ 289	$ 859	$ 200	$ 630
Los Alamos National Laboratory	300	300	76	385	385	518	300	345
Oak Ridge National Laboratory	7,000	6,587	3,866	7,216	7,216	7,571	7,200	9,373
Subtotal	8,300	7,887	5,117	7,890	7,890	8,948	7,700	10,348
Other Contractors								
Princeton Plasma Physics Laboratory	1,100	1,532	1,241	874	874	1,558	500	1,139
Subtotal	1,100	1,532	1,241	874	874	1,558	500	1,139
Total, General Plant Projects	$ 9,400	$ 9,419	$ 6,358	$ 8,764	$ 8,764	$10,506	$ 8,200	$11,487

HIGH ENERGY PHYSICS

	FY 1985 Actual			FY 1986 Estimate			FY 1987 Request	
	B/A	OBS	B/O	B/A	OBS	B/O	B/A	B/O
Contractors								
Multi-Program Laboratories								
Brookhaven National Laboratory..	$ 5,700	$ 5,700	$ 4,107	$ 5,457	$ 5,461	$ 4,100	$ 6,000	$ 4,700
Subtotal.....	5,700	5,700	4,107	5,457	5,461	4,100	6,000	4,700
Other Contractors								
Fermi National Accelerator Laboratory.....	3,000	3,000	2,261	2,872	2,876	2,100	3,300	2,600
Stanford Linear Accelerator Center.....	1,500	1,500	1,653	1,628	1,628	1,200	1,900	1,500
Subtotal.....	4,500	4,500	3,914	4,500	4,504	3,300	5,200	4,100
Total, General Plant Projects.....	$10,200	$10,200	$ 8,021	$ 9,957	$ 9,965	$ 7,400	$11,200	$ 8,800

	FY 1985 Actual			FY 1986 Estimate			FY 1987 Request	
	B/A	OBS	B/O	B/A	OBS	B/O	B/A	B/O
Contractors								
Multi-Program Laboratories								
Lawrence Berkeley Laboratory....	$ 2,500	$ 2,500	$ 1,702	$ 2,394	$ 2,394	$ 1,900	$ 2,600	$ 2,100
Los Alamos National Laboratory..	950	894	1,214	622	632	600	970	600
Subtotal.....	3,450	3,394	2,916	3,016	3,026	2,500	3,570	2,700
Other Contractors								
Bates Accelerator (MIT).....	50	50	161	335	336	200	430	400
Subtotal.....	50	50	161	335	336	200	430	400
Total, General Plant Projects.....	$ 3,500	$ 3,444	$ 3,077	$ 3,351	$ 3,362	$ 2,700	$ 4,000	$ 3,100

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

Contractors	FY 1985 Actual B/A	FY 1985 Actual OBS	FY 1985 Actual B/O	FY 1986 Estimate B/A	FY 1986 Estimate OBS	FY 1986 Estimate B/O	FY 1987 Request B/A	FY 1987 Request B/O
Multi-Program Laboratories								
Oak Ridge National Laboratory...	$ 0	$ 0	$ 0	$ 481	$ 481	$ 56	$ 0	$ 200
Los Alamos National Laboratory..	200	200	544	962	962	238	500	691
Pacific Northwest Laboratory....	2,000	2,000	1,688	962	962	921	1,000	1,817
Lawrence Livermore Nat. Lab. ...	200	200	170	240	240	169	500	462
E.I. Du Pont De Nemours and Co., Inc.....	0	0	117	0	0	84	0	0
Subtotal.....	2,400	2,400	2,519	2,645	2,645	1,468	2,000	3,170
Other Contractors								
Inhalation Toxicology Res. Inst.	200	197	1,250	482	484	437	1,000	642
Rochester, University of.....	0	0	0	0	0	0	0	0
Utah, University of.....	0	0	275	0	0	313	0	0
Oak Ridge Assoc. Universities...	75	75	31	0	0	54	500	158
California, Univ. of at Davis...	0	0	- 2	0	0	146	0	0
California, Univ. of at San Francisco.....	0	0	0	0	0	0	0	0
Forest Service, U.S.....	0	0	17	0	0	10	0	0
Georgia, Univ. of at Athens.....	50	50	200	0	0	149	0	30
Headquarters.....	0	0	0	0	79	0	0	0
Subtotal.....	325	322	1,771	482	563	1,109	1,500	830
Total, General Plant Projects.....	$ 2,725	$ 2,722	$ 4,290	$ 3,127	$ 3,208	$ 2,577	$ 3,500	$ 4,000

MULTIPROGRAM ENERGY LABORATORIES - FACILITIES SUPPORT
ENVIRONMENTAL COMPLIANCE

	FY 1985 Actual			FY 1986 Estimate			FY 1987 Request	
	B/A	OBS	B/O	B/A	OBS	B/O	B/A	B/O
Contractors								
Multi-Program Laboratories								
Oak Ridge National Laboratory..	$ 0	$ 0	$ 0	$ 3,894	$ 3,894	$ 1,349	$ 3,000	$ 3,000
Total, General Plant Projects....	$ 0	$ 0	$ 0	$ 3,894	$ 3,894	$ 1,349	$ 3,000	$ 3,000

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
SUMMARY OF GENERAL PURPOSE EQUIPMENT
(In Thousands of Dollars)
OFFICE OF ENERGY RESEARCH
ENERGY SUPPLY R&D
BASIC ENERGY SCIENCES

	FY 1985 Actual			FY 1986 Estimate			FY 1987 Request	
	B/A	OBS	B/O	B/A	OBS	B/O	B/A	B/O
Contractors								
Multi-Program Laboratories								
Argonne National Laboratory.....	$ 2,000	$ 2,000	$ 2,000	$ 1,924	$ 1,924	$ 1,924	$ 2,200	$ 2,200
Ames Laboratory.....	160	160	160	135	135	135	155	155
Total, General Purpose Equipment..	$ 2,160	$ 2,160	$ 2,160	$ 2,059	$ 2,059	$ 2,059	$ 2,355	$ 2,355

MAGNETIC FUSION ENERGY

	FY 1985 Actual			FY 1986 Estimate			FY 1987 Request	
	B/A	OBS	B/O	B/A	OBS	B/O	B/A	B/O
Contractors								
Multi-Program Laboratories								
Oak Ridge National Laboratory...	$ 3,800	$ 3,800	$ 3,443	$ 3,801	$ 3,801	$ 3,801	$ 3,820	$ 3,820
Total, General Purpose Equipment.	$ 3,800	$ 3,800	$ 3,443	$ 3,801	$ 3,801	$ 3,801	$ 3,820	$ 3,820

HIGH ENERGY PHYSICS

	FY 1985 Actual			FY 1986 Estimate			FY 1987 Request	
	B/A	OBS	B/O	B/A	OBS	B/O	B/A	B/O
Contractors								
Multi-Program Laboratories								
Brookhaven National Laboratory..	$ 3,900	$ 3,900	$ 4,644	$ 3,734	$ 3,734	$ 3,734	$ 4,200	$ 4,200
Total, General Purpose Equipment.	$ 3,900	$ 3,900	$ 4,644	$ 3,734	$ 3,734	$ 3,734	$ 4,200	$ 4,200

NUCLEAR PHYSICS

	FY 1985 Actual			FY 1986 Estimate			FY 1987 Request	
	B/A	OBS	B/O	B/A	OBS	B/O	B/A	B/O
Contractors								
Multi-Program Laboratories								
Lawrence Berkeley Laboratory....	$ 800	$ 800	$ 938	$ 766	$ 766	$ 766	$ 1,230	$ 1,000
Total, General Purpose Equipment.	$ 800	$ 800	$ 938	$ 766	$ 766	$ 766	$ 1,230	$ 1,000

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

	FY 1985 Actual			FY 1986 Estimate			FY 1987 Request	
	B/A	OBS	B/O	B/A	OBS	B/O	B/A	B/O
Contractors								
Multi-Program Laboratories								
Oak Ridge Assoc. Universities...	$ 40	$ 40	$ 40	$ 38	$ 38	$ 38	$ 32	$ 32
Pacific Northwest Laboratories..	0	0	384	962	962	962	1,000	1,000
Total, General Purpose Equipment..	$ 40	$ 40	$ 424	$ 1,000	$ 1,040	$ 1,000	$ 1,032	$ 1,032

MULTIPROGRAM ENERGY LABORATORIES - FACILITIES SUPPORT

	FY 1985 Actual			FY 1986 Estimate			FY 1987 Request	
	B/A	OBS	B/O	B/A	OBS	B/O	B/A	B/O
Contractors								
Multi-Program Laboratories								
Oak Ridge National Laboratory...	$ 0	$ 0	$ 0	$ 962	$ 962	$ 962	$ 1,000	$ 1,000
Total, General Purpose Equipment..	$ 0	$ 0	$ 0	$ 962	$ 962	$ 962	$ 1,000	$ 1,000

BES FACILITIES

Mr. BEVILL. Please provide the operating funds for each of the major facilities funded by BES. Please provide this information for FY 1985, FY 1986, and FY 1987 by program providing the funding.

Dr. TRIVELPIECE. I will be happy to provide this information for the BES programs for the record. Information on the High Energy Physics program was provided in response to an earlier question.

[The information follows:]

BASIC ENERGY SCIENCES MAJOR FACILITIES FUNDING

[In thousands of dollars]

Facility operating expense	FY 1985	FY 1986	FY 1987
High Flux Beam Reactor (HFBR):			
Materials Sciences	11,643	11,325	12,200
Chemical Sciences	435	415	450
Total HFBR	12,078	11,740	12,650
National Synchrotron Light Source (NSLS):			
Materials Science	11,850	13,250	15,700
Chemical Sciences	7,265	6,940	7,750
Total NSLS	19,115	20,190	23,450
Intense Pulsed Neutron Source (IPNS): Materials Sciences	7,130	7,100	7,350
Total IPNS	7,130	7,100	7,350
High Voltage Electron Microscope—Tandem Facility (HVEM): Materials Science	1,350	1,380	1,620
Total HVEM	1,350	1,380	1,620
Oak Ridge Electron Linear Accelerator (ORELA): Nuclear Sciences	3,395	3,151	3,543
Total ORELA	3,395	3,151	3,543
High Flux Isotope Reactor (HFIR): Nuclear Sciences	10,100	10,547	11,333
Total HFIR	10,100	10,547	11,333
Combustion Research Facility (CFR): Chemical Sciences	5,715	5,400	5,930
Total CRF	5,715	5,400	5,930
National Center for Electron, Microscopy (NCEM): Materials Sciences	2,200	2,050	2,220
Total NCEM	2,200	2,050	2,220
Stanford Synchrotron Radiation, Laboratory (SSRL):			
Nuclear Sciences	6,900	6,796	8,068
Materials Sciences	1,140	1,107	1,800
Total SSRL	8,040	7,903	9,868
Los Alamos Neutron Scattering Center (LANSCE): Materials Sciences	300	0	1,300
Total LANSCE	300	0	1,300

SUPERCOMPUTER RESEARCH

Mr. BEVILL. How much funding is provided in FY 1985, FY 1986, and FY 1987 for Supercomputer Research.

Dr. TRIVELPIECE. The information is shown in a table which I would like to insert in the record.

[The information follows:]

SUPERCOMPUTER RESEARCH FUNDING

[In thousands of dollars]

	FY 1985	FY 1986	FY 1987
Operating Expenses	20,625	22,900	22,650
Capital Equipment	500	500	500
Total	21,125	23,400	23,150

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

Mr. BEVILL. Does the environmental research done in this program support the Secretary's environmental clean up initiative? How?

Dr. TRIVELPIECE. Yes. The environmental research done in the Biological and Environmental Research Program supports the Secretary's environmental clean up initiative in a number of distinct ways. Our ecological research program has investigated the movement of water and contaminants through porous media. From this research, transport models have become established which are now widely used by the waste management community to describe contaminant migrations. Such models will be utilized in the Secretary's clean up initiative.

Our instrumentation research program has produced advanced measurement technology which will be used in the clean up initiative. For example, thermoluminescence dosimetry and in situ gamma ray spectrometry are routine operational measurement techniques that are used to determine the total amount of radiation in a given location, and the concentration of elements emitting that radiation.

Methodological techniques are also developed within the research program which, when they are validated and documented, become the standardized procedures employed in an operational program or a major environmental survey. A range of air, soil, and water sampling procedures were developed under our research program which now are established as the preferred methodology for environmental measurement.

Our Environmental Measurements Laboratory, which conducted research leading to many of these advanced procedures, is internationally recognized for it's measurement expertise and is responsible for managing a Quality Assessment Program with funds provided by the ES&H program in conjunction with the Secretary's environmental clean up initiative.

Mr. BEVILL. What do you consider to be the most important initiatives in the biological research program?

Dr. TRIVELPIECE. There are a number of initiatives that are expected to be of major importance to the Department, and more generally to public health concerns. One area that is receiving increased emphasis is called molecular epidemiology. This rapidly developing area of biomedical science provides a powerful and sensitive means for allowing us to identify individuals who are either extremely resistant to, or extremely susceptible to, a given type of exposure. For example, the DOE program has discovered certain types of proteins that repair damaged genes. We have found that individuals that have defects in some of these proteins are overly susceptible to certain types of cancer. Research aimed at correcting these defects can thus have a major beneficial impact on such individuals.

The Department has also taken the lead in research on new methods for mutation detection and we propose to support the development and application of new DNA-based technologies for the measurement of heritable mutations in human populations. This will permit us to evaluate the extent to which current policy effects the disease burden on future generations. A different newly developed approach is now being used to measure mutations in our own generation by studying radiation exposure at Hiroshima and Nagasaki. Several other promising approaches for the direct measurement of molecular changes in humans are under development. We believe that these new technologies will have a very significant impact on the early detection and prevention of human disease.

The Biological and Environmental Research program is cooperating with Savannah River Laboratory/DOE Defense Programs in characterizing the biomass and community structure of microbial communities at depths of 100 to 1200 feet. The microbial ecology of this region is unknown, and we expect to break new ground that will lead to mitigation of ground water contamination at DOE sites. Also investigated will be metobolic activity that could lead to *in situ* degradation of deep or-

ganic contaminants at SRL and other DOE sites. The first question to be answered is whether specialized microbiota exist at these depths, and if so, what are the conditions that permit their survival in hostile low oxygen, low nutrient, and at times low moisture environments. Culturing such organisms can lead to a practical answer for degrading organic contaminants in place. The long term result could be a major advance in cleaning up deep contaminations from land waste disposal nationwide.

Several new instrumentation developments show great promise for detection of biological changes at the cellular and sub-cellular level. The large machines at our national laboratories, developed by nuclear physicists to study atomic processes, can also be used to determine the three-dimensional structure of protein and genes. A new electron microscope is at an advanced stage of construction at the University of Chicago. The microscope will be able to distinguish between two atoms separated by less than one Angstom (one hundred million objects each having a one Angstom diameter if placed side by side in a straight line would measure less than half an inch). The importance of these developments lies in the fact that the structure of proteins and nucleic acids determine the precise biological role they play (e.g., whether a protein stimulates or inhibits the growth of a cell). An understanding of structure will, for example, help us to design drugs and vaccines much more rapidly and inexpensively than is currently possible.

Development of high speed flow cytometers at the Los Alamos and Lawrence Livermore National Laboratories now make it practical to sort and separate specific chromosomes and genes on a large scale. These instruments will provide biologists with libraries of well defined genetic material which will, for example, be important for the study of genetic diseases.

A new laser-based technique called Fluorescence Line Narrowing Spectroscopy developed at DOE's Ames Laboratory is able to detect exceedingly small levels of cancer-causing chemicals bound to genes at levels roughly equivalent to finding a needle in the proverbial hay stack. The importance of this can be understood by recalling that sometimes a decade or more elapses between time of exposure to a carcinogen and the appearance of symptoms. By the time symptoms appear, the disease has progressed to a stage that is difficult to cure. However, if methods were available that could allow us to see which genes these defect-causing chemicals were affecting, we might be able to identify high risk individuals well in advance of clinical symptoms and to intervene at a time when treatment is effective. Detection, measurement, and identification of these adducts, as well as defining their precise location in the genome, is a challenging technical problem which is receiving increased emphasis, and which can have a major impact on the health and economy of the Nation.

Heightened public awareness of indoor radon and its cancer causing potential has resulted in significant media, Congressional, OMB and public attention directed toward the Department of Energy's Biological and Environmental Research radon program. To address the complexity of this issue and the potential public health impacts, this research program will expand in FY 1987.

The Biological and Environmental Research program has been making important contributions to radon research since the early 1950's as part of its radium dial painters' study. These earlier efforts were expanded over time and now include instrumentation development, source characterization and transport studies, and both animal inhalation studies and uranium miner epidemiologic studies. The FY 1987 BER radon program will specifically target for increased effort those areas of greatest scientific uncertainty and most serious public health impact. To assure a comprehensive approach to this nationally important issue, ongoing cooperative efforts include formal liaisons with EPA (which is expanding its non-research radon program) as well as with other Federal and international bodies.

The radon initiative will provide funding to new, innovative peer reviewed proposals in the following areas: factors influencing indoor radon progeny concentrations and particle size distribution, biological dosimeters, unique epidemologic studies, tissue microdosimetry, and inhalation studies.

NUCLEAR MEDICINE ACCOMPLISHMENTS

Mr. BEVILL. What are the principal accomplishments of the nuclear medicine program?

Dr. TRIVELPIECE. Historically, the most noteworthy accomplishment of this program has been to establish nuclear medicine as a major medical specialty. Nuclear medicine is now an essential component of every major medical facility in the country. The National Laboratories continue to serve the nuclear medicine community

directly by producing many radioisotopes that are not available through the private sector.

The research program emphasizes the development of instrumentation and new radiopharmaceuticals. In FY 1986 this program received a $3 million add-on that has been used to augment brain and heart studies and the development of therapeutic uses of heavy particle beams. The laboratories were asked to submit proposals for new initiatives in these areas, and after review, the funds were distributed among the ones that best met the criteria of quality, relevance and appropriateness. Several imaging instruments with greatly improved spatial resolution are in advance stages of development and will be used to refine our understanding of the functional irregularities in Alzheimer's and other brain diseases.

Another significant development is the use of radioactive monoclonal antibodies not only in diagnosis but in therapy. These agents make it possible to deliver highly localized radiation to cancer cells with minimal radiation of surrounding normal tissue. This has potentially widespread application for the treatment of inoperable metastatic disease.

Large accelerators used to study atomic and nuclear processes have recently been successfully applied to treat various types of central nervous system malformations, including ocular melanomas and tumors close to the spinal cord. Follow up times have been 2–4 years with an overall success rate exceeding 90%. The Biological and Environmental Research nuclear medicine accomplishments are described in a recent publication, "Health and Environmental Research Summary of Accomplishments," which is being provided for the record.

Mr. BEVILL. What steps have you taken to assure that the best and highest priority nuclear medicine programs are funded.

Dr. TRIVELPIECE The manager of the Department's program is a nuclear medicine physician with extensive clinical and research experience in this field. Through his contacts with the nuclear medicine community, we maintain a continual perspective on research opportunities, priorities, and needs. In addition, we have organized ad hoc reviews to examine the entire nuclear medicine program. This involves special site visits to the key laboratories and extensive interaction between the review group and the many principal investigators that comprise the nuclear medicine research program. Furthermore, specific laboratory peer review site visits are scheduled on a regular basis for the major onsite and offsite projects. Periodically, we convene a meeting of the nuclear medicine contractors for the purpose of exchanging information on research findings and discussing priority opportunities for new research directions. In addition to internal reviews, new proposals are subject to outside peer review by recognized experts in the relevant areas.

MENDEZ FOUNDATION

Mr. BEVILL. I have some questions Mr. Dowdy would like me to ask you. What is the status of the Jackson State University, Ana G. Mendez Educational Foundation and Lawrence Berkely Laboratory relationship?

Dr. TRIVELPIECE This joint program was initiated in 1983 as an expansion of the ongoing collaborative research and education program involving the Lawrence Berkeley Laboratory and Jackson State University. The expanded program involves three Puerto Rican colleges affiliated with the Mendez Educational Foundation. The purpose of this overall effort is to strengthen the science, mathematics and computer science research and teaching programs at both Jackson State University and the three Mendez colleges by providing technical assistance and support from scientists and staff at Lawrence Berkeley Laboratory. During the last several years, the consortium members have prepared a long range program plan and developed and submitted proposals for support of this program to private foundations and Federal agencies, including DOE. To date, funding has been received from the Carnegie Corporation of New York for support of a precollege science teaching improvement program in Puerto Rico and from the National Institutes of Health for a premedical student training program at the Mendez schools. The National Science Foundation has also funded the initial development of a scientific computing center at Jackson State University.

Mr. BEVILL. What is the status of the special funding request?

Dr. TRIVELPIECE. In the FY 1986 conference report, the Department of Energy was directed to provide $1.5 million for a cooperative program involving Lawrence Berkely Laboratory, Jackson State University and the Mendez Foundation. In FY 1986 because of the Gramm-Rudman-Hollings Act, this total has been reduced to $1,443,000. We received the formal request on March 7, 1986, from Jackson State University on behalf of the Mendez Educational Foundation and the Lawrence

Berkeley Laboratory. This proposal requests $1,500,000 for the first year of this overall program. The proposal is currently undergoing peer review by science education experts in other Federal agencies and in private foundations. Suggestions and comments from these reviewers on the proposal will be sent to the consortium members for incorporation, as necessary, in a revised proposal and program plan. We anticipate that this process will be concluded by mid-May.

Mr. BEVILL. What is the Department of Energy's long term commitment to this consortium?

Dr. TRIVELPIECE. The Department is actively involved in the President commitment to strengthen the Nation's Historically Black Colleges and Universities. We have sponsored in the past and will continue to do so in the future activities designed to strengthen the ties between our national laboratories and predominantly minority colleges and universities. We have included $300,000 in our FY 1987 budget request for the University Research Support Program to continue several collaborative programs involving our laboratories and several minority colleges and universities. However, no funds are specifically requested in FY 1987 budget, however, for the continuation of the Jackson State University/Mendez/Lawrence Berkeley Laboratory consortium at the level requested. We believe that the substantial long-term support requested by the consortium would be more appropriately considered by private foundations and Federal agencies concerned with undergraduate science program improvement as this type of activity is not directly related to the mission of this Department.

HIGH ENERGY PHYSICS—SSC

Mr. MYERS. If the Congress decides to move foward with the Superconducting Super Collider (SSC) what is the capability for funding in 1987? What work must proceed actual construction?

Dr. TRIVELPIECE. During FY 1984–86, funding for SSC R&D has been a part of the high energy technology subprogram. This subprogram supports both accelerator R&D and experimental facility R&D. The goal of the accelerator R&D includes the development of new and improved concepts, techniques, and devices for the acceleration, storage, and transport of high energy particle beams. This has included studies on superconducting magnets and systems and their optimization, with focus on the needs for the SSC. The FY 1987 request for this subprogram would maintain overall an approximately constant level of effort with FY 1985 and FY 1986 pre-Gramm-Rudman-Hoilings. We believe that we can accommodate the highest priority SSC needs within this request. Additional R&D on the magnets and other SSC systems will be needed in FY 1987. A major required activity will be systems tests of a set of full-scale prototype magnets connected in a string. There is a need to fabricate further magnet prototypes including important participation by industry to incorporate further cost saving ideas and manufacturing techniques. There is also need for further improvements to the superconducting wire and R&D studies on other SSC systems to develop cost and performance optimized designs.

Mr. MYERS. Are there any technological questions remaining to be solved before starting construction on SSC?

Dr. TRIVELPIECE. The basic technological questions relating to feasibility have been solved by the highly successful SSC R&D of the past 2 to 3 years, which has in turn built upon the earlier work on superconducting magnet R&D at the national laboratories and the demonstrated success of the world's first superconducting accelerator, the four-mile Fermilab Tevatron. These successes provide a firm base for the Conceptual Design Report which is due in April and the Department's review this spring and summer. There remain many detailed studies to develop cost and performance optimized designs of SSC systems. Since I discussed these earlier, I will simply highlight here the magnet systems tests and the importance of industrial involvement in development of the magnet fabrication process.

Mr. MYERS. Why were no funds requested for this project in 1987?

Dr. TRIVELPIECE. The direction and emphasis of the FY 1987 accelerator R&D program, particularly in the area of superconducting accelerator magnets and associated systems, will depend on the results of the Department's review this summer. We felt it premature to identify specific funding for the project prior to completion of our review. We do not, at this time, anticipate the need for a supplemental request for SSC R&D in FY in 1987. We believe that by focusing on the most critical SSC R&D requirements, the FY 1987 needs for SSC R&D can be accommodated within the requested budget for high energy technology where it was funded in FY 1985 and FY 1986. As indicated earlier, the FY 1987 request for the high energy technolo-

gy subprogram permits about the same overall level of activity as in FY 1985 and FY 1986 prior to Gramm-Rudman-Hollings.

Mr. MYERS. Can you predict any useful discoveries or technological developments the SSC will yield?

Dr. TRIVELPIECE. Superconducting wire performance has already been substantially improved by about 50 percent over the wire available for the Tevatron magnets. Superconducting wire is used in many new areas of technology, including the fabrication of large magnets required for Nuclear Magnetic Resonance imaging, which shows promise of being the most important medical diagnostic tool since the development of the x-ray tube. The improved superconductor will make these magnets cheaper and more readily available, helping doctors to make early and accurate diagnosis.

The SSC would clearly play an important role in education and training, providing outstanding interest and research challenges to a generation of scientific and engineering students. Based on a historical pattern that has been repeated time and again, the most useful and far-reaching scientific discoveries with greatest impact on everyday life may not materialize for many years and usually will be those which are not foreseen at all.

Basic scientific exploration which at the time appeared far removed from ordinary experience has led to innovations which have completely changed our lives from what they otherwise would have been. The television, radio, and electrical industries grew out of the research that led to Maxwell's understanding that electricity and magnetism are different manifestations of a single underlying force; the nation's world-leading electronics industry is based on the quantum mechanical discription of matter that was developed earlier this century when scientists explored the structure of the atom; and modern global navigational systems rely on the new understanding of space and time given by Einstein's Special Relativity. Basic research is an investment in the future well-being and security of the nation. Based on the high returns from frontier basic research in the past, these investments can be anticipated to pay off handsomely in the future.

NUCLEAR PHYSICS—CEBAF

Mr. MYERS. What will we learn from the CEBAF? How long will construction take?

Dr. TRIVELPIECE. CEBAF is designed to study the structure of nuclei in a critical energy region. At CEBAF energies, the transition between the classical nucleon-meson description of nuclei and the emerging quark-gluon picture takes place. Experiments performed at CEBAF will also give detailed information on the motions and interactions of the nuclear constituents and on the location of electric charges inside nuclei.

The construction is expected to take five years beginning in FY 1987 and assuming the funding profile given in the Construction Data Sheet.

BASIC ENERGY SCIENCES

Mr. MYERS. Is there any particular reason that 1-2 GeV Synchrotron Radiation Source should go to Lawrence Berkeley Laboratory?

Dr. TRIVELPIECE. The Lawrence Berkeley Laboratory has conducted extensive research and development on the technical issues related to construction of a 1-2 GeV Synchrotron Radiation Source. This laboratory is the only laboratory that has a fully developed design. The design is similar to a 1.3. GeV facility which LBL designed and which was reviewed and included in the FY 1984 request to Congress, but was not funded. The LBL has the leading world-wide expertise on insertion device design around which this advanced facility would be built. With its X-ray optics center, the insertion device design team and its superior accelerator design expertise going all the way back to the cyclotron inventor Professor Lawrence, LBL is the natural choice for siting the 1-2 GeV Synchrotron Radiation Source.

Mr. MYERS. What is the total cost of the 6 GeV Synchrotron Radiation Source at Argonne? Why build this project and the one at Berkeley?

Dr. TRIVELPIECE. A preliminary estimate of the total construction cost of the 6 GeV Synchrotron Radiation Source at Argonne is in the $350 million range. The reason why a 6 GeV Synchrotron Radiation Source and 1-2 GeV Synchrotron Radiation Source at Berkeley are both needed has been discussed in detail by several committee reports including the DOE Planning Study for Advanced Synchrotron Radiation Sources, the National Research Council report on Major Facilities for Materials Research and Related Disciplines and the Energy Research Advisory Board review of the National Research Council report. Very briefly, the various scientific

groups that have looked at the problem of advancing the field of synchrotron radiation research have all recommended building new facilities which are designed from the beginning to incorporate insertion devices. The range of radiation required by the community cannot be accommodated by a single facility considering the optimization of design. One community requires hard X-rays represented by the 6 GeV source, whereas the second community requires ultraviolet/soft X-rays represented by the 1–2 GeV source. In view of the tremendous demand for these facilities, their usefulness for science and technology and the fact that not one design can satisfy both communities, two facilities have been proposed and are requested. Their total capacity or ability to serve users and their construction schedule will be tailored to the schedule of resources available and should be built as soon as possible according to the various committees.

OIL AND GAS GEOSCIENCES PROGRAM AT DOE

Mrs. BOGGS. In December, 1985, the Interstate Oil Compact Commission passed a resolution calling upon DOE to promote the production and use of domestic oil and gas by redirecting funds for an expanded research and development program in the geosciences associated with the discovery of oil and gas.

Is the Department aware of this position by the IOCC? Have you begun to examine this proposal?

Dr. TRIVELPIECE. The Department is aware of the position taken by IOCC and is currently using the Energy Research Advisory Board for examination of the recommendations of IOCC and related recommendations by other groups.

Mrs. BOGGS. Last month the Department's Energy Research Advisory Board established a new panel, the Solid Earth Science Panel, to examine the state of DOE's research and development program in the geosciences associated with the discovery of oil and gas.

Is the Department working to support this panel in its examinations? What is your reaction to the concerns expressed by the members of ERAB when they set up this panel?

Dr. TRIVELPIECE. The Solid Earth Science Panel of ERAB was established at the specific request of Secretary Herrington and the Department is providing full support for it. As this action suggests, the Department viewed the concerns expressed by ERAB to warrant immediate and serious consideration. Secretary Herrington called, in particular, for a study to "help ensure that our R&D investments in this area are appropriate in terms of both the proper role of government and our future needs."

Mrs. BOGGS. It seems that there is a developing need for a federal role to continue research into the geosciences associated with the discovery of oil and gas. Do you agree?

Dr. TRIVELPIECE. I agree and the Department currently has underway a limited number of research projects with the potential for assisting the discovery of oil and gas. The studies of the Solid Earth Science Panel of ERAB now in progress are, in my view, an essential step in determining the appropriate nature and level of future geosciences research in DOE.

PERSONNEL TRENDS—NATIONAL LABORATORIES

Mr. FAZIO. Would you please supply for the record a list of net personnel gains and losses for each of the DOE national laboratories over the past 5 years?

Dr. TRIVELPIECE. A list of net personnel gains and losses for each of the DOE national laboratories over the past five years is shown in a table I would like to insert in the record.

[The information follows:]

DOE NATIONAL LABORATORIES PERSONNEL LEVELS

[Past 5 years—in full-time equivalent persons]

Laboratory	1981	1982	1983	1984	1985
Argonne National Laboratory	4,997	4,339	4,188	4,117	3,901
Brookhaven National Laboratory	3,502	3,258	3,231	3,207	3,200
Lawrence Berkeley Laboratory	2,996	2,644	2,601	2,687	2,695
Oak Ridge National Laboratory	5,023	4,725	4,709	4,743	4,994
Pacific Northwest Laboratory	2,100	1,900	1,915	1,934	2,065
Idaho National Engineering Laboratory	5,070	4,919	4,663	4,920	5,065

DOE NATIONAL LABORATORIES PERSONNEL LEVELS—Continued

[Past 5 years—in full-time equivalent persons]

Laboratory	1981	1982	1983	1984	1985
Lawrence Livermore National Laboratory	7,215	7,370	7,451	7,774	8,063
Los Alamos National Laboratory	7,166	7,184	7,102	7,457	7,918
Sandia National Laboratory	7,900	7,929	7,989	8,178	8,418
Total	45,969	44,268	43,849	45,017	46,319

SUPERCONDUCTING SUPER COLLIDER

Mr. FAZIO. After the Secretary makes his review of the pros and cons of the Superconducting Supercollider in April, when will he decide whether to proceed in FY 1987?

Dr. TRIVELPIECE. The SSC Conceptual Design Report will be thoroughly reviewed this spring and summer by the Department for feasibility and cost. This review will serve as important input for the Secretary's decision this summer on whether to seek authorization to initiate construction of the project in FY 1988. This decision will determine the emphasis and level of the planned FY 1987 accelerator R&D effort for the SSC.

Mr. FAZIO. Whose court is the ball in? Would you make a FY 1987 reprogramming request? Or are you expecting Congress to reprogram funds?

Dr. TRIVELPIECE. The FY 1987 request includes funding for the high energy technology subprogram, the category in which SSC R&D is funded. The funding requested for this subprogram in FY 1987 permits about the same overall level of activity as in FY 1985 and in FY 1986 prior to the Gramm-Rudman-Hollings reductions. SSC R&D needs are given consideration in this category in FY 1987, however, it is premature to assign a specific funding to SSC R&D until the results of the upcoming Secretarial review are known. At this time, we do not expect that a reprogramming of funds or a supplemental request will be necessary. We believe that by focusing on the most critical SSC requirements, the incremental FY 1987 request for high energy technology.

Mr. FAZIO. If the decision is to proceed, how much money would be required in FY 1987?

Dr. TRIVELPIECE. Continued development of magnets and other systems will need to be carried out in FY 1987. This would include systems tests of a set of full-length magnet prototypes connected in a string, important participation by industry in the R&D studies to incorporate further cost-savings into the magnet design, and further improvements to superconducting wire. The Central Design Group has indicated a need of $30–40 million in FY 1987. We believe that by concentrating on the highest priority needs, SSC R&D can be accommodated within the FY 1987 request for high energy technology without the need for a supplementary funding request.

Mr. FAZIO. The Secretary says the SSC is a good thing to do and the only question is whether we can afford it in fiscal 1987. If that is the case, it strikes me as strange that the Department would make this affordability assessment without first determining how much states or other cost share entities might be able to contribute to offset the federal costs.

Dr. TRIVELPIECE. Plans for FY 1987 have never envisioned anything but R&D. The question of affordability which the Secretary addressed refers to the subsequent construction funding which would not begin before FY 1988. You are correct that it would be desirable to know of non-Federal cost sharing before assessing affordability; however, it is difficult to enter into negotiations with potential foreign partners or States until the Department has made a commitment to proceed with the project. We have here a classic "which came first, the chicken or the egg" situation. We believe that the most crucial next step is for the Department to come to a decision on whether it wants to proceed with the project.

PROPOSED REGULATIONS ON ALLOWABLE COSTS

Mr. FAZIO. Do proposed regulations on private industry's lobbying with Federal dollars extend so far as to prohibit people who work at the national laboratories from explaining their programs and problems directly to members of Congress? If so, why?

Dr. TRIVELPIECE. The notice of proposed rulemaking, published in the Federal Register on March 4, 1986, implements section 1534 of Title XV, Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1986. The proposed regulation does not prohibit people who work at the national laboratories from explaining their programs and problems directly to members of Congress. The proposed regulation does prohibit such people from engaging in activities to influence Congressional actions being taken on legislation. The proposed regulation also does allow travel costs for such people testifying at regularly scheduled Congressional hearings, or providing Congressional members with technical or scientific advice, directly related to contract performance, so long as a written request is made to the national laboratory personnel by the Chairman or Ranking Minority Member of a Congressional Committee or Subcommittee.

RESCISSIONS

Mr. FAZIO. The Department has proposed deferring funding for certain university facilities added by the Congress to the 1986 fiscal year budget, among vast numbers of other DOE deferrals. The Secretary has informed the Congress that he intends on changing those deferrals to rescissions, an admission that the real DOE intent is to kill the programs. However, he has yet to submit the actual papers changing the deferrals to rescissions. The more time elapses, the longer it will be before the 45 day lay over period for rescissions starts to run. When will these deferrals be officially reclassified?

Dr. TRIVELPIECE. The deferrals will be officially reclassified and transmitted to the Congress as rescissions on March 12, 1986.

STATEMENT OF ALVIN W. TRIVELPIECE, DIRECTOR, OFFICE OF ENERGY RESEARCH DEPARTMENT OF ENERGY

Mr. Chairman and members of the subcommittee, it is a pleasure to appear here today to present the FY 1987 budget request for several of the programs supported by the Office of Energy Research (ER). At a previous hearing, I discussed the Magnetic Fusion Energy Program. Today, I would like to discuss the following programs: High Energy and Nuclear Physics, Basic Energy Sciences, Biological and Environmental Research, Energy Research Analysis, University Research Support, University Research Instrumentation, and Multiprogram Energy Laboratories-Facilities Support. The High Energy and Nuclear Physics programs are under the General Science and Research appropriation. All of the other programs are under the Energy Supply R&D appropriation. The FY 1987 budget request for all ER programs is shown in Table 1.

TABLE 1.—OFFICE OF ENERGY RESEARCH SUMMARY BY PROGRAM

[Budget authority in millions of dollars]

	Fiscal year 1985	Fiscal year 1986		Fiscal year 1987 request
	Conf. Approp.	Conf. Approp.	Adjusted	
General science & research:				
High energy physics	$541.9	$517.1	$494.8	$546.7
Nuclear physics	181.5	171.9	164.5	224.2
General science program direction	2.2	2.4	2.1	2.5
Transfer of appropriation	0	−6.0	−6.0	0
Subtotal	725.6	685.4	655.4	773.4
Energy supply—R&D:				
Basic energy sciences	410.8	450.8	433.8	441.4
Magnetic fusion energy	429.6	379.8	365.5	333.0
Biological & environmental research	187.7	187.0	179.9	196.6
Energy research analysis	3.0	2.7	2.6	3.5
University research support	10.1	10.7	10.3	11.0
University research instrumentation	4.9	6.5	6.2	5.0
Multiprogram energy laboratories-facilities support	33.2	42.1	39.8	60.2
Advisory & oversight program direction	2.9	2.8	2.7	2.9
Policy and management	0.5	0.1	0.1	0.5
Subtotal	1,082.7	1,082.5	1,040.9	1,054.1
Total ER	1,808.3	1,767.9	1,696.3	1,827.6

At this point I would like to discuss each of the programs mentioned above in some detail.

HIGH ENERGY AND NUCLEAR PHYSICS

The High Energy and Nuclear Physics programs seek the answers to questions that man has asked for many hundreds of years, namely, what are the basic constituents of matter and what forces govern them. While conducting this research, the High Energy and Nuclear Physics programs, over the years, have made significant contributions not only to energy resource development, but to education, health, industry and national defense. Contributions to the economic growth and prosperity of the Nation have come directly from the results of the research, from technological spinoffs and from the training of tomorrow's scientists through participation of university graduate students in the research. Through science and technology transfer, these ideas and people have made contributions in a variety of industries including medical instrumentation and therapy, control and instrumentation of industrial processes, the production of nuclear energy, and many applications of electronic and computer techniques.

The High Energy and Nuclear Physics programs are closely related not only in terms of overall goals, but also in the types of facilities and equipment used to reach these goals and the impact that research in one program has on the other. Both seek to contribute to an understanding of the basic constituents of matter and the forces that govern them. Nuclear Physics does so by studying the nucleus; High Energy Physics does so by studying the most fundamental of particles that comprise the nucleus and all other matter.

Experiments in both the High Energy and Nuclear Physics programs depend on large experimental facilities that accelerate beams of particles to collide with stationary targets or head-on with other moving particle beams. Studying the results of these collisions helps scientists to learn about the properties of the underlying building blocks and basic forces involved. Although research progress depends on the availability of these forefront accelerator and colliding beam facilities, as well as on the detectors that record the results of the collisions, progress also depends on a continuing interplay of advancements in experiment, theory and technology. Often the range of experiments possible is determined by available technology; and physicists frequently have to invent new equipment and technology to carry out the most important experiments.

In the High Energy Physics program, research utilizing accelerators is conducted principally at four accelerator laboratories in the U.S. two in Europe and one in Japan and encompasses more than 150 user groups. The Nuclear Physics program, carried out at seven national facilities, accommodates approximately 70 user groups. The program also utilizes facilities in Canada and Europe.

HIGH ENERGY PHYSICS

Progress toward improving our understanding of the fundamental nature of energy and matter and their most elemental transformations has come rapidly in recent years. In developing this knowledge, five U.S.-supported high energy physicists have won or shared in Nobel prizes during the last seven years. The major current objective of high energy physics research is unification of the basic forces into a single theoretical framework; in other words, a single theory that would describe all of the interactions of matter and energy existing in the universe.

The electromagnetic force describes how atoms and molecules are formed and is the cornerstone to understanding chemistry, electronic communications and biological processes. The weak nuclear force describes processes such as the radioactive decay of nuclei. The strong nuclear force helps describe how the sun and the stars produce so much energy and holds the nucleus together. Together with the weak nuclear force, it also describes the relative abundance of the chemical elements. The

gravitational force, perhaps the most familiar of the forces of nature, explains such things as how objects fall and planets move in their orbits.

Results of high energy physics research have led to an increasingly better understanding of the forces of nature and the unifying connections among them. A part of the recent progress in high energy physics has been the conceptual unification of the weak nuclear and electromagnetic forces into a single "electroweak" framework. In addition, a theory of the strong interaction force has emerged which is consistent with observation. There is increasing anticipation that the unification of the strong nuclear and electroweak forces into one "grand unified" framework may be possible, thus reducing the apparent number of forces in nature to two. The ultimate goal is a "super-grand" unification that would bring all of the forces in nature into a single unified framework. (An example of such a theory, called "superstrings," has recently attracted much attention.)

The picture of nature provided in terms of the electroweak and strong forces and the quark and lepton constituents is known as the Standard Model. The most significant recent experimental results all reinforce the predictions of the Standard Model.

Experiments are in preparation to use the new capabilities coming into operation in early FY 1987 and the near future to search for phenomena which do not conform to the Standard Model and in particular for phenomena predicted by grand unified theories.

Before I discuss the budget request, I would like to report on some of the recent accomplishments in the High Energy Physics program. The Fermi National Accelerator Laboratory (Fermilab) Tevatron, the world's first high energy accelerator using superconducting magnets, provided beam for numerous experiments with portions at energies up to 800 billion electron volts (GeV) in 1984 and 1985. The substantial quantity of data recorded in the very productive 1985 run is now being analyzed. The new antiproton source produced a high energy antiproton beam in the Summer of 1985. The first proton-antiproton collisions at 1600 GeV (800 GeV on 800 GeV) were observed with the Collider Detector at Fermilab (CDF) in a test run in the Tevatron colliding beam mode. In FY 1987 the accelerator is expected to operate at energies near 900 GeV per beam for both fixed target and colliding beam experiments.

The Alternating Gradient Synchrotron at Brookhaven National Laboratory (BNL) has the world's highest energy beam of polarized protons and high intensity kaon beams for precision studies of rare kaon decays.

Successful development of the Stanford Linear Collider (SLC) at the Stanford Linear Accelerator Center (SLAC) will provide an essential demonstration of the technical feasibility of the new linear collider concept, which is a critical step toward future cost-effective extensions of electron-positron reaction energies beyond the maximum energy practical with circular accelerators. It will also permit significant new physics with 50 GeV on 50 GeV electron-positron colliding beams. Good progress is being made on fabrication and installation of components for SLC. Systems tests are scheduled to begin later in FY 1986, and first 50 GeV on 50 GeV colliding beam experiments are planned early in 1987.

FY 1987 HIGH ENERGY PHYSICS BUDGET REQUEST

The FY 1987 request for the High Energy Physics program is $546.7 million, which consists of $427.5 million for Operating Expenses, $77.5 million for Capital Equipment and $41.7 million for Construction (Table 2).

TABLE 2.—HIGH ENERGY PHYSICS

[Budget authority in millions of dollars]

	Fiscal year 1985 Conf. Approp.	Fiscal year 1986		Fiscal year 1987 request
		Conf. Approp.	Adjusted	
Operating expenses:				
Physics research	$106.3	$111.0	$106.3	$118.6
Facility operations	172.7	183.1	175.1	213.4
High energy techology	90.2	92.4	88.4	95.5
Subtotal	369.2	386.5	369.8	427.5
Capital equipment	58.7	73.1	70.0	77.5
Construction	114.0	57.5	55.0	41.7
Total high energy physics	541.9	517.1	494.8	546.7

A major part of the funding for the program is required to meet the direct needs of the accelerator laboratories to develop, maintain and operate the major accelerator, colliding beam and detector facilities. The high energy particle accelerator and colliding beam facilities to be operated by the Department in FY 1987 include: first operation for research of Fermilab's collider and CDF providing 900 GeV on 900 GeV on 50 GeV electron-positron collisions; the Tevatron superconducting magnet and Mark II detector at the Stanford Linear Accelerator Center (SLAC) providing 50 GeV on 50 GeV electron- positron collisions; the Tevatron superconducting magnet proton synchroton at Fermilab providing proton beams of about 800 GeV and numerous secondary beams for fixed target experiments; the 50 GeV linear electron accelerator at SLAC providing injected beams for the PEP storage ring (15 GeV on 15 GeV) and for the SPEAR storage ring (4 GeV on 4 GeV) in addition to the SLC mentioned above; and the 30 GeV proton synchrotron, the Alternating Gradient Synchrotron (AGS), at Brookhaven National Laboratory (BNL). Each of these DOE accelerator centers provides a unique set of experimental research capabilities, complementary to the others.

The facilities at these laboratories provide the source of experimental data for most of the High Energy Physics research, more than 75% of which is carried out by university-based scientists. In addition to research carried out using high energy accelerators in the U.S., the Department's High Energy Physics program supports experiments which use the capabilities of unique foreign accelerators and also some experiments which do not require beams from particle accelerators.

The FY 1987 request for operating expenses is $427.5 million. The major features of the program in FY 1987 will be the first operation for research of the 900 GeV on 900 GeV proton-antiproton colliding beam capability provided by Tevatron I, and of the 50 GeV on 50 GeV electron-positron colliding beam capability provided by the SLC. The program will also include operation and research utilization of the recently upgraded Tevatron fixed target facilities at Fermilab, of the BNL AGS with its fixed target program including rare kaon decay experiments and its unique high energy polarized proton beam, and of the SLAC PEP and SPEAR colliding beam facilities. There are major incremental costs associated with operation of the new world forefront Tevatron and SLC collider facilities. These two new research capabilities ensure a world competitive position for the U.S. program. The request brings these new research facilities into operation and accommodates an overall facility utilization level near 50 percent. The request provides continuing support for university-based groups including U.S. user group efforts at U.S. and foreign accelerators, non-accelerator experiments, and theoretical research efforts. The FY 1987 program also includes funding for a continuation of advanced technology accelerator and detector R&D. I will make some specific remarks about the Superconducting Super Collider (SSC) after I have completed summarizing the High Energy Physics budget.

The FY 1987 capital equipment request of $77.5 million meets the highest priority needs for the detectors required to implement strong research programs based upon the new capabilities provided by the Tevatron proton-antiproton collider at Fermilab and by the SLC electron-positron collider at SLAC. The equipment request for FY 1987 is essential to make it possible for the D-Zero and Stanford Linear detectors to be completed in FY 1989 and thereby permit most effective utilization of the new U.S. High Energy Physics facilities being completed in FY 1986 at Fermilab and SLAC.

The FY 1987 request for construction funds is $41.7 million. The projects are listed in Table 3. This program includes continued work on upgrading of the central computing capability at Fermilab ($4.1 million) which is required for the analysis of the large volume of new physics data coming from the Tevatron program, to continue construction of the AGS Accumulator/Booster at BNL ($3.5 million) and to complete construction of the SLC ($1.0 million) and Tevatron I ($0.4 million).

TABLE 3.—HIGH ENERGY PHYSICS

[Budget authority in millions of dollars]

Construction	FY 1987 request	TEC	Completion date (fiscal year)
Tevatron I (81-E-218)	$0.4	$84.0	1987
Stanford Linear Collider (84-ER-133)	1.0	115.4	1987
Central computing upgrade, Fermilab (86-R-104)	14.1	24.1	1988
AGS accumulator/booster, BNL (86-R-105)	3.5	26.4	1989
Accelerator improvements and modifications project (87-R-101)	11.5	11.5	1989
General plant projects (87-R-102)	11.2	11.2	1989
Total construction	$41.7		

Funds are requested for Accelerator Improvement and Modifications Projects ($11.5 million) that are critical on an annual basis to maintain the scientific effectiveness and the operating reliability and efficiency of the accelerator and colliding beam facilities. The request also provides $11.2 million for General Plant Projects (GPP) which are required to keep the general plant of the laboratories (e.g., buildings, roads, utilities) in operating condition.

This brings me to the SSC, which has been the subject of great interest, both in the scientific realm and in the public realm. I would like to state briefly where we are now and what the Department's plans are with regard to the SSC.

As I indicated in my discussion of accomplishments, excellent progress has been achieved in recent years in improved understanding of the fundamental constituents of matters and the basic forces that influence their behavior. Physicists now have the "Standard Model" which provides a framework within which these things can be viewed consistently. However, the Standard Model is not the final answer. Many very fundamental questions such as the origin of particles masses cannot be answered within the theory. There is much left to do.

The facility upgrades nearing completion at Fermilab and SLAC will provide two forefront research capabilities to the beginning of the 1990's which will permit exploration in new physical domains and exciting new discoveries. However, these research capabilities cannot explore the TeV mass scale where breakthroughs in fundamental understanding and new phenomena are expected. Access to the TeV mass scale will definitely test many key features of the Standard Model, and permit exploration of an entirely new domain never before explored.

In late 1983, the Department developed a plan to initiate preliminary R&D related to an SSC. This R&D program was to carefully assess costs, examine cost-redirection opportunities, and resolve technical and design issues, providing crucial input upon which to base an informed judgment about proceeding with the SSC at an appropriate time. The activities begun in FY 1984 have been continued into FY 1985 and FY 1986.

The accelerator R&D related to the SSC initiated in FY 1984 was achieved as a redirection of efforts from earlier planned accelerator R&D. The 1984 work included R&D on technical options (particularly with regard to superconducting magnets), cost reduction studies, and a Reference Designs Study (RDS) which established technical feasibility and developed credible preliminary cost and schedule estimates. Research and development activities in FY 1985 included R&D to confirm RDS assumptions; cost reduction studies; further R&D on superconducting magnet designs to provide the technical basis for selection, near the end of that fiscal year, of the magnet type which would yield the best performance at the lowest facility cost; studies to develop a cost performance optimized design; and development of a technical site criteria report. The technical progress of the R&D activities has been excellent. Critical milestones have been met. In FY 1986, SSC-related research and development includes advanced accelerator R&D to develop a cost/performance optimized design for the selected type of superconducting magnet, to develop cost-effective techniques for fabrication of full length superconducting magnets, and to develop conceptual systems designs. This program will provide the technical information for an indepth Departmental review of the SSC this summer. Although a continuing R&D program is required in FY 1987, the direction and emphasis of the program, especially the work on superconducting accelerator magnets and associated systems, will depend on the results of this review.

NUCLEAR PHYSICS

The Nuclear Physics program supports the basic research necessary to identify and understand the fundamental features of atomic nuclei and their interactions. Nuclear processes have guided the evolution of the universe, fueled solar burning, and determined the interplay of the primary forces of nature—the strong nuclear force, the electromagnetic force, and the weak force. The study of nuclear physics consequently lies at the core of fundamental scientific research.

In terms of trained manpower, new knowledge, and advanced instrumentation, the Nuclear Physics program continues to be a vital factor in America's long-term investment in its technological future. Nuclear knowledge, techniques, instruments, and applications are an integral part of American society. These serve as the basis for our national defense strategy, for therapeutic and diagnostic medical application, for generation of electrity with nuclear reactors (fission now and fusion in the future), and for a large and diverse array of applications in industry.

The role of mesons as nuclear constituents and their utility as nuclear probes continues to be an important component of nuclear physics research, but new theoretical insights have opened the door to a more profound level of understanding. Neutrons and protons are now known to be composed of quarks and gluons, and mesons are now known to be composed of quark-antiquark pairs. Nuclear theorists, along with high energy theorists, are investigating the ways in which quarks are confined together in "bags" of three to make up neutrons and protons. A more fundamental theory of the nuclear force is emerging based on the quantum chromodynamics (QCD) model of quarks and gluons. This new theory alters in ever expanding ways the concepts and phenomena of nuclear physics. Exploring these new concepts requires higher energies than have been available to the Nuclear Physics program up to now.

Before turning to the budget request, let me summarize several Nuclear Physics accomplishments achieved during the last year.

The best quantitative measurements for testing the theory that protons and neutrons are made up of quarks come from precision scattering experiments carried out with various high energy beams of electrons and muons. Results of these precision scattering experiments have given detailed information about the quarks and their motion inside the proton and neutron. Recently, the European Muon Collaboration (EMC) at Cern used muon beams to bombard nuclei spanning the periodic table from hydrogen to uranium. Researchers observe that the high energy muons scattered differently from the quarks bound inside nuclei than from the quarks in free protons and neutrons. This unexpected observation, called the EMC effect, has been verified and extended by research at the Nuclear Physics facility at the Stanford Linear Accelerator Center.

A variety of theoretical models has been proposed to explain the EMC effect. These include (1) an increased size of the three-quark bag (nucleon) within the nucleus; (2) the existence of six quark bags within the nucleus; (3) enhancement of the number of pions within the nucleus; and (4) conventional nuclear structure effects from momentum and binding energy distributions. Since each of these theoretical models can explain the existing electron and muon data, it is important to test with further experiments the differences identified in the various models. An experiment using the polorized proton beams at the Los Alamos Meson Physics Facility (LAMPF) now appears to rule out the contributions of increased pion density. A detailed investigation at the Massachusetts Institute of Technology (MIT) Beta Laboratory suggests that interactions between quark motion and bulk nuclear matter collerations may be more important than previously realized leading to enhanced understanding of lower energy phenomena.

In collaboration with experimental groups from the Laboratory for Heavy Ion Research at Darmstadt, West Germany (GSI), and the Universities of Frankfurt and Heidelberg, scientists from Yale have discovered narrow peaks in the spectrum of positron emissions from collisions involving supercritical Coulomb fields. Such fields can occur during the collision of heavy ion projectiles and targets consisting of various combinations of heavy elements. Early experiments indicated that spontaneous ionization of the vacuum was responsible for the production of electron-positron pairs. However, this source of the positrons is being discounted because the position of the peak does not move as predicted with changes of projectile and target species.

A second suggestion that the peaks arise from the decay of long-lived super-heavy element formation is also losing favor. Recently, it has been suggested that the peaks could result from the decay of one or more previously unknown light elementary bosons created in the heavy ion collision. Alternative possibilities are that the peaks arise from the decay of a three electron complex consisting of two positrons

and one electron or from tidal effects of the atomic electron cloud. Ion source improvements at Argonne National Laboratory (ANL) are being implemented in order to investigate this phenomenon with coincidence experiments between the positrons and possible electron partners.

Recent progress at Lawrence Berkeley Laboratory's (LBL) Bevalac includes the first experimental determination of the compressibility of hot nuclear matter by studying the emission of pions from colliding nuclear systems. LBL scientists also made the first measurement of hydrodynamical flow effects in heavy ion collisions. Recent experiments have used the Plastic Ball detector to detect and measure over one hundred particles simultaneously emitted when nuclei accelerated to high energy collide with nuclei stationary in the laboratory. These programs mark the beginning quantitative studies to determine the equation of state of hot, dense nuclear matter. Knowledge of the nuclear equation of state, in particular the compressibility of nuclear matter, determines our ability to understand collapsing stars as they consume all of their nuclear fuel. Astrophysical calculations require that nuclei have a "soft" equation of state (very easily compressed) in order to bounce back from a gravitationally driven implosion, creating a shock wave that may lead to a supernova explosion. Results from high energy heavy ion collisions, however, indicate that nuclear matter is very "hard." This disparity leads to a distinct, unresolved scientific dilemma.

Recently, the elastic scattering of electron-type neutrinos from electrons was measured for the first time by scientists using the beam stop at LAMPF as an intense source of electron-type neutrinos. In about six months of data taking, over 30 billion neutrinos passed through the detection apparatus in order to produce 51 scattering events. Three distinct possible results were permitted by various theoretical models prior to this result, but only one is consistent with the observation. The experiment is continuing, and with the expected level of statistics, further definitive statements about characteristics of the electroweak interaction will be made.

The FY 1987 Nuclear Physics experimental program will continue its emphasis on the fundamental properties of nuclear matter and on the experimental investigation of the behavior of quarks inside nuclei and of the way in which quarks determine the characteristics of nuclei. In nuclear theory, emphasis in FY 1987 will be on understanding the limitations of the present quantum chromodynamics theories as exact theories of the nuclear force, on improving these theories, and on understanding the ways in which new quark configurations would become evident.

TABLE 4.—NUCLEAR PHYSICS

[Budget authority in millions of dollars]

Operating expenses	Fiscal year 1985 Conf. Approp.	Fiscal year 1986		Fiscal year 1987 request
		Conf. Approp.	Adjusted	
Medium energy nuclear physics	$73.9	$76.5	$73.1	$85.0
Heavy ion nuclear physics	49.0	52.4	50.2	63.7
Low energy nuclear physics	13.3	12.6	12.1	15.7
Nuclear theory	9.3	9.4	9.0	10.5
Subtotal	145.5	150.9	144.4	174.9
Capital equipment	12.7	14.0	13.4	16.0
Construction	23.3	7.0	6.7	33.3
Total nuclear physics	181.5	171.9	164.5	224.2

FY 1987 NUCLEAR PHYSICS BUDGET REQUEST

The FY 1987 budget request for the Nuclear Physics program is $224.2 million. Of that amount, $174.9 million is for Operating Expenses; $16.0 million is for Capital Equipment; and $33.3 million is for Construction (Table 4). The FY 1987 request includes $25.0 million for initiation of construction plus $6.25 million in operating expense funds for supporting research and development of the Continuous Electron Beam Accelerator Facility (CEBAF). CEBAF has the highest priority for new construction in basic nuclear research in the United States.

CEBAF will be a new, single-purpose facility for basic nuclear research. Its combination of continuous beam, high intensity, and high energy will be unique in the world and will be important to maintain American's position of worldwide leader-

ship in basic nuclear research. It will be operated as a user facility serving a nationwide and international community of nuclear scientists. The central instrument of CEBAF will be a high intensity, high duty factor electron accelerator with an energy range of 0.5–4.0 billion electron volts (GeV). The construction project includes an initial complement of experimental equipment and support facilities necessary to perform scientific experiments using CEBAF's high quality electron and photon beams.

Upon completion of construction, scientists can investigate the ways in which the quarks bound in nuetrons and protons influence the makeup and behavior of nuclei, to determine how quarks interact while embedded within nuclear matter, and to test quantum chromodynamics as the fundamental theory of the strong nuclear force. Experiments in which electrons knock protons or neutrons out of nuclei will yield information about how energy and momentum is distributed among the nucleons bound inside nuclei and will tell us about correlations among nucleons in nuclei. At the high energy limit of electron scattering, experiments are, to a good approximation, only sensitive to effects of electrons scattering from individual quarks within the nuclei. Under these circumstances, nuclei can be described as a loose collection of free quarks. At energies below 1 GeV, electron scattering from nuclei can be described accurately as electrons scattering from the protons, neutrons, and mesons known to be in nuclei. The energy capability of CEBAF would permit quantitative examination of the transition between these complementary descriptions of nuclei.

As is the case with High Energy Physics, the Nuclear Physics program depends upon the operation of large and complicated accelerator facilities to provide the variety of projectile beams and energies required to conduct the nuclear research program. Of the Operating Expenses request, $93.3 million is needed for operation of these facilities. In FY 1986, the national facilities are expected to achieve an overall utilization rate of 55 percent. These national facilities are: the Clinton P. Anderson Meson Physics Facility at Los Alamos National Laboratory (LANL); the Bates Linear Accelerator Center at MIT; the SuperHILAC/Bevalac at LBL); the Argonne Tandem/Linac Accelerator System (ATLAS); the Holifield Heavy Ion Research Facility at Oak Ridge National Laboratory (ORNL); the 88-inch Cyclotron at LBL; and the Double MP Tandem/AGS facility at Brookhaven National Laboratory (BNL). To complement these national facilities, the Nuclear Physics program also supports on-campus accelerators at Yale, Duke, the University of Washington, and Texas A&M, each of which is being upgraded to maintain its effectiveness.

The FY 1987 Nuclear Physics budget request includes funds for initial heavy ion nuclear research and 1000 hours of accelerator operations at the Alternating Gradient Synchrotron (AGS) at BNL. Upon completion in FY 1986, the Tandem/AGS Heavy Ion Transfer Line will provide heavy ion beams to the AGS for acceleration to the unique energies of 14 GeV per mass unit. This unique capability offers the possibility that scientists may be able to create exotic new conditions of nuclear matter at high temperatures and densities.

The Capital Equipment request of $16.0 million would provide for particle detection systems, data acquisition and analysis systems, and instrumentation to improve the performance of Nuclear Physics accelerators. These funds are essential for the effective operation and utilization of the National accelerator facilities by the Nuclear Physics program.

Of the total request, $14.8 million is required for projects at BNL, LBL, ORNL, ANL, LAMPF, Bates Linear Accelerator Center at MIT, Oak Ridge Associated Universities, and Duke University. The Nuclear Physics program has landlord responsibility for providing the general purpose equipment at LBL, and $1.2 million is requested for that purpose.

The FY 1987 Construction request of $33.3 million (Table 5) includes the Continuous Electron Beam Accelerator Facility ($25.0 million), the Accelerator Improvements and Modifications Projects ($4.3 million), and the General Plant Projects ($4.0 million). These projects are needed to maintain the scientific effectiveness, reliability and efficiency of Nuclear Physics facilities.

TABLE 5.—NUCLEAR PHYSICS

[Budget authority in millions of dollars]

Construction	Fiscal year 1987 request	TEC	Completion date (fiscal year)
Continuous electron beam accelerator facility (87-R-203)	$25.0	$236.0	1992
Accelerator improvements and modifications projects (87-R-201)	4.3	4.3	1989
General plant projects (87-R-202)	4.0	4.0	1989
Total construction	33.3		

GENERAL SCIENCE PROGRAM DIRECTION

The FY 1987 budget request for General Science Program Direction is $2.5 million. These funds are required to provide for the salaries, benefits, travel and other expenses associated with 39 full-time equivalents in the Office of the Associate Director for High Energy and Nuclear Physics and associated support staff required to admininster these programs.

Now let me turn to the Basic Energy Sciences program.

BASIC ENERGY SCIENCES

The goal of the Basic Energy Sciences (BES) program is to uncover the basic scientific and engineering knowledge that can be used by the Government and the private sector to develop new concepts, products, materials and processes. Although the principal focus of the BES program is aimed at underpinning the Department's energy and defense goals, a number of other important National goals are also supported. The U.S. leadership in science and technology, the stimulation of economic growth, and the training of tomorrow's scientists are additional goals to which BES contributes as a result of the support of basic research. While contributions from basic research cannot always be identified immediately or directly, the knowledge that flows from this research forms the current foundation on which new ideas and concepts grow in each of these areas.

The BES program annually supports approximately 1200 individual research projects in the physical, biological and mathematical sciences. These projects are selected on the basis of scientific excellence, relevance to BES' support of DOE long-term goals, and their contribution toward a balanced research program. This research is carried out largely by scientists at universities and National laboratories across the country.

Important results of supporting university researchers are the knowledge and technology transfer that occur when graduate students enter the private sector after completing their studies. In addition to research at universities and DOE laboratories, to a lesser extent, BES also supports research in industry and maintains contact there through a variety of mechanisms. These include participation in workshops, peer review panels, and the use by industry of the specialized reseach facilities supported by BES.

BES research covers the following seven areas: materials sciences; chemical sciences; nuclear sciences; mathematical sciences; engineering and geosciences; biological sciences; and advanced energy projects. The ultimate impact of the research results from over 1200 projects will be far reaching, beyond what is immediately obvious.

The following six examples, three of which I will discuss at some length and three that I will summarize in a sentence or two, provide some insight into the scope and diversity of the BES program.

The examples I want to discuss at length are in the Materials Sciences, Chemical Sciences, and the Advanced Energy Projects subprograms.

MATERIALS SCIENCES ACCOMPLISHMENT

In the Materials Sciences subprogram, very promising research is being supported on superconducting materials—materials that conduct electricity (electrons) without any loss of electrical energy. Normally, these materials are compounds of metallic elements and become superconducting only at low temperatures. Materials which carry electrical current are very important in view of the numerous crucial applica-

tions involving the transmission of electrons; electric current examples including cables that carry electrical power, wires that conduct current in motors and generators, and electrical conductors in devices that produce magnetic fields, such as for medicine for visualizing pathological problems in the human body. Most of the materials used for these applications currently are metals such as copper. However, recently much progress has been made in the discovery and understanding of electrically conducting organic materials. Organic materials made of non-metallic elements like carbon, hydrogen, sulfur, etc., have the potential of being cheaper, better, and lighter and could improve the operational characteristics of devices or energy systems.

During the past year, an exciting development occurred in the design, synthesis, and characterization of a new organic superconductor. The achievement was the result of a collaborative effort among researchers at Argonne National Laboratory, Sandia National Laboratories, and Strem Chemical Company. The achievement was the discovery of the highest ambient pressure superconducting transition temperature (5° above absolute zero) yet observed for a synthetic organic superconductor.

CHEMICAL SCIENCES ACCOMPLISHMENTS

In the Chemical Sciences subprogram, promising research is being conducted in solar photochemical energy conversion. Sunlight is used by plants in taking carbon dioxide from the air and water and converting it into food and combustible materials. Chemical scientists are working to understand this process which is at the same time the most common and the most complex of the processes which occur in the environment around us.

First, plant photosynthesis itself is the subject of intense investigation. Major advances have recently been made in understanding how sunlight makes the initial separation of electrical charges occur in the plant's "reaction center." This insight is being used to design simple molecules which can absorb light and use its energy to drive useful chemical reactions. A triad of molecules recently prepared at Argonne National Laboratory sets a new record for photoinduced charge separation, 2.4 millionths of a second. Though exceedingly brief by human standards, this is a long time by molecular standards. It involves two successive electron transfers in the same molecule.

Photochemists are also exploring photoinduced, thermodynamically unfavorable fuel-forming reactions at coated semiconductor electrodes and on surfaces of very small catalyst-covered semiconductor particles. While all of these systems are still in their infancy, there is every likelihood that at least one will become fundamental in future solar-related technology.

ADVANCED ENERGY PROJECTS ACCOMPLISHMENTS

A major recent accomplishment has been the development at the Princeton Plasma Physics Laboratory of a laboratory-scale x-ray laser, generating an extremely narrow beam of coherent ("marching in tune") x-rays. The importance of developing a laboratory-size x-ray laser cannot be overstated. It opens up new vistas in a number of applications, including the possibility of three-dimensional holographic imaging of live sub-microscopic objects. This, and other implications of short wavelength lasers for medical and other uses—for example in microlithography—make such lasers of keen practical importance. This accomplishment, listed recently by Science News Digest as one of last year's 100 outstanding innovations, can place the United States in the forefront of a new technology, that of laboratory-scale x-ray lasers.

On another front, for several years now, scientists have been exploring a new approach to generating electromagnetic radiation, known as "free electron laser." Recently, researchers from the Lawrence Berkeley and Lawrence Livermore Laboratories invented and demonstrated a method of using free electron lasers to generate, with great efficiency, extremely powerful beams of electromagnetic radiation. Their approach formed the basis for a major free electron laser development project for defense applications, now underway at Livermore.

OTHER BES ACCOMPLISHMENTS

Each of our other subprograms in BES have accomplishments similar to the ones I have just discussed. I don't want to elaborate on each of them, but I would like to mention three examples of accomplishments from the other subprograms within BES (Applied Mathematical Sciences, Engineering and Geosciences, and Biological Energy Research).

In the Applied Mathematical Sciences area, a new class of high resolution finite difference methods for modeling compressible fluid flow problems with discontinuities has been developed. These methods incorporate the nonlinear wave propagation properties into the algorithm, leading to methods that are stable and robust in the neighborhood of shock waves and slip surfaces and are still highly accurate in regions of smooth flow. These methods have resolution capabilities that are close to the theoretical maximum attainable and represent a major advance in the state-of-the-art that is unlikely to be surpassed in the near future. These methods are being incorporated into large application programs used in the weapons design and laser fusion projects.

In the Engineering subprogram, considerable progress is being made on new design methods for electrical equipment which use magnetic materials; e.g., motors, generators, and transformers. Magnetic materials suffer from hysteresis. Under cyclic excitation, such as alternating current, hysteresis causes ambiguities in the behavior of electromagnets, with the state of the magnet depending on its past history. The presence of those ambiguities has imposed constraints on the design of electrical equipment. In general, the constraints are reflected in more costly, less energy efficient electrical systems, ranging from power generating plants, through components for electric power distribution, down to consumer products. Recent research, involving the use of certain novel nonlinear mathematical operations, has yielded a method for resolving the ambiguities, thus leading to new, more powerful design methods, and eventually to improved electrical machinery and transmission systems.

In the Biological Energy Research program, one major achievement has been the complete elaboration of the metabolic pathway of methane gas formation from carbon dioxide in organisms that inhabit various anaerobic environments including man-made systems (digestors and some sewage treatments) and natural systems (swamps, animal digestive tracts, sediments). This pathway is a unique one in which an entirely distinct set of cofactors and enzymatic reactions have been characterized and described biochemically. These contributions are crucial to designing new approaches for enhanced biological methane production and to better understanding of the position of methane in the global carbon cycle.

BASIC ENERGY SCIENCES FACILITIES

The kind of research progress depicted by the above examples is made possible, in part, by the large state-of-the-art facilities that are supported by the BES program. These facilities are not only an integral part of the Basic Energy Sciences program, but they also serve the general scientific community. Industry, university, and Government researchers have access to these facilities for promising research projects. These facilities are available at no cost to the user if the project is of high technical merit, cannot be carried out without access to the facility and is not proprietary. If the research requires the use of the facility but is of a proprietary nature, a user fee is charged. This combination of laboratory, university and industry researchers working side by side is extremely beneficial. The Government gains because researchers supported by our program interact with their counterparts in the private sector and have access to the unique instrumentation and equipment that are provided at no cost to the Department by these counterparts. Both industry and the university communities gain by having access to some of the most advanced facilities in the world.

Several state-of-the-art facilities are in operation. Each promises to open whole new areas of research opportunities. These facilities include: the National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory; the Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory; the 1.5 MeV High Voltage Electron Microscope and the Atomic Resolution Microscope (ARM) located at Lawrence Berkeley Laboratory's National Center for Electron Microscopy; and the Combustion Research Facility (CRF) at Sandia Livermore. As an example of the type of U.S. industrial research possible at one of the National user facilities, I would like to briefly discuss the research at NSLS.

NATIONAL SYNCHROTRON LIGHT SOURCE

There has been a very enthusiastic response to the NSLS from industrial scientists performing experiments on the x-ray and vaccum ultraviolet (VUV) storage rings. The industries presently involved with the NSLS include Allied Corporation, Ashland Oil, AT&T Bell Labs, Dupont, EXXON, General Electric, Gulf, IBM, Mobil, Stouffer Chemical, Union Carbide, Universal Oil Products, and Xerox. These industries are interested in a wide variety of research that they expect may ultimately

lead to significant technological innovation. It is worth mentioning several of the primary areas of investigation below.

MICROELECTRONICS

There is large program being carried out by IBM scientists in the area of microelectronics. On Port U6 of the VUV storage ring, highly-collimated intense soft x-ray beams have been used to replicate sub-micron integrated circuit features onto photoresist materials. Features as small as 0.25 micron (one-one hundred thousandth of an inch) have been replicated successfully with high aspect ratios. With the addition of a temperature-controlled clean room to provide stable, contamination-free exposures, and an alignment system capable of producing circuit dimensions smaller than 0.5 microns, IBM plans to fabricate an experimental working integrated circuit.

If the IBM effort on U6 proves the technical feasibility of using synchrotron radiation for microcircuit replication, there could be a greatly expanded use of synchrotron radiation in this country with storage rings becoming an integral part of semiconductor factories. Indeed, efforts have begun in Germany and Japan to develop compact superconducting storage rings for the semiconductor industry. The NSLS is organizing a workshop this month to consider how a similar effort might be undertaken in the U.S. and what would be the roles of private industry and of the Federal Government (through the expertise and the facilities of the National laboratories).

CATALYSIS

A number of the companies mentioned above have a common interest in studying catalytic reactions in the hope of developing more efficient catalysts. By using the high intensity synchrotron radiation available from the NSLS, it will be possible to complete x-ray absorption and diffraction studies of catalysts during active operating conditions (elevated temperature and pressures) while the surfaces still remain active. These studies should help determine the structures and orientations of complicated organic molecules during catalysis. EXXON scientists on beam X10 are also using small angle x-ray scattering to study the pore structures in rock since this relates to the rate of flow of oil through various geological formations. The same technique is also being used to characterize the aggregation of organic macromolecules in petroleum crude since this has a direct bearing on the refining process.

STRUCTURE OF MATERIALS

There have been a number of experiments carried out by scientists from industrial laboratories in the area of structure of materials. Examples include the first structure determination of alpha-chromium phosphate by a DuPont team using the X13 powder diffraction beam, and a study carried out on the X11 beam of chromate and dichromate corrosion inhibitors in aqueous solutions for aluminum and its alloys.

University and Government laboratory scientists have carried out a wide range of topography and x-ray diffraction, absorption, and scattering experiments on technologically important metal alloys and semiconductors to study defects and microstructures. The success of these experiments is leading to expanded use of NSLS by materials scientists from all sectors of the scientific community.

A list of the major BES user facilities is contained in Table 6.

TABLE 6.—BASIC ENERGY SCIENCES FACILITIES

High Flux Beam Reactor (HFBR)—Brookhaven National Laboratory.
National Synchrotron Light Source (NSLS)—Brookhaven National Laboratory.
Intense Pulsed Neutron Source (IPNS)—Argonne National Laboratory.
High Voltage Electron Microscope-Tandem Facility—Argonne National Laboratory.
Oak Ridge Electron Linear Accelerator (ORELA)—Oak Ridge National Laboratory.
High Flux Isotope Reactor (HFIR)—Oak Ridge National Laboratory.
Combustion Research Facility (CRF)—Sandia National Laboratories, Livermore.
National Center for Electron Microscopy—Lawrence Berkeley Laboratory.
Stanford Synchrotron Radiation Laboratory (SSRL)—Stanford University.
Los Alamos Neutron Scattering Center (LANSCE)—Los Alamos National Laboratory.

FY 1987 BASIC ENERGY SCIENCES BUDGET REQUEST

The FY 1987 budget request for the BES program is $441.4 million, which consists of $380.1 million in Operating Expenses, $31.8 million in Capital Equipment and $29.5 million in Construction funds (Table 7). This request supports the core program for each of the research areas with modest increases in each of the subprogram areas for major user facility operations and for enhancements to selected promising research areas. The requested increase for facilities will cover increased costs related to power, fuel, and essential operating personnel, as well as safeguards and safety requirements.

TABLE 7.—BASIC ENERGY SCIENCES

[Budget authority in millions of dollars]

Operating expenses	Fiscal year 1985 Conf. Approp.	Fiscal year 1986		Fiscal year 1987 request
		Conf. Approp.	Adjusted	
Materials sciences	$132.2	$139.5	$134.3	$156.9
Chemical sciences	78.6	81.2	78.1	86.4
Nuclear sciences	39.6	43.1	41.4	46.9
Applied mathematical sciences	34.5	39.4	37.9	32.8
Engineering and geosciences	26.1	26.6	25.6	29.4
Advanced energy projects	10.1	7.6	7.3	9.0
Biological energy research	12.4	12.4	12.0	14.6
Program direction	3.8	3.6	3.5	4.1
Subtotal	337.3	353.4	340.1	380.1
Capital equipment	31.1	27.3	26.2	31.8
Construction	42.4	70.1	67.5	29.5
Total basic energy sciences	410.8	450.8	433.8	441.4

Of the total FY 1987 Operating Expenses request of $380.1 million, approximately 30% will be spent to operate and carry out research at the major BES facilities. As I noted earlier, these facilities are used not only by the Department, but also by other Federal agencies, by industry and by university researchers. They represent an investment in the Nation's long-term research and technological future. The budget request will ensure continued operation and access to these facilities in FY 1987. In addition, to maintain existing facilities, the FY 1987 budget also begins the necessary first step toward meeting the Nation's need for the next generation of advanced facilities.

The highest priority BES-related facilities proposed are: 1-2 GeV Synchrotron Radiation Source (LBL), continued research and development on the 6 GeV Synchrotron Radiation Source (ANL), and research and development of an Advanced Steady State Reactor (ORNL). The concept and need for these facilities have been reviewed and recommended by several committees, most notably and recently the National Research Council (NRC) Study of Major Materials Facilities and the DOE Energy Research Advisory Board review of the NRC report. The 1-2 GeV facility is being proposed for construction by requesting architect-engineer and long-lead procurement work in FY 1987, since significant preconstruction R&D has been conducted in the past. Research and development for the 6 GeV facility and the Advanced Steady State Reactor will be continued.

The FY 1987 budget request also continues support for the materials initiative that began in FY 1984. That activity currently consists of a Center for Advanced Materials at LBL, improvements at the Stanford Synchrotron Radiation Laboratory and expanded activities at the BNL National Sychrotron Light Source. The economic health and national security of the U.S. require that we maintain a commanding lead in high technology. The ongoing advanced materials research activity is being organized to provide maximum benefit to the Nation. Industry is participating in the design of the research program to assure that it addresses America's high technology needs.

The Capital Equipment request for FY 1987 is $31.8 million. The requested funding will assure that researchers involved in our program continue to have the modern, sophisticated equipment needed to conduct advanced research. This level of funding is necessary to meet ongoing research requirements, additional commitments associated with the new facilities and additional equipment for selected areas

of promising research. Examples of equipment to be pruchased include high resolution nuclear magnetic resonance equipment, compute peripherals (e.g., disk and tape units), fluid chromatograph for use in analyzing chemical solutions, infrared spectometers, chemcial vapor deposition apparatus, and an x-ray microprobe analyzer.

Table 8 details the construction request for FY 1987. Three of the projects, as mentioned earlier, are associated with the materials initiative which began in FY 1984: the Center for Advanced Materials (CAM) at LBL, the Stanford Synchrotron Radiation laboratory (SSRL), and the National Synchrotron Light Source (NSLS) at BNL.

TABLE 8.—BASIC ENERGY SCIENCES CONSTRUCTION SUMMARY

[Budget authority in millions of dollars]

	Fiscal year 1987 request	TEC	Completion date (fiscal year)
Center for advanced materials (84–ER–112)	$10.5	$40.2	1988
Beam lines and support area construction, NSLS (84–ER–111	2.6	19.4	1987
Stanford Synchrotron Radiation Laboratory enhancement (84–ER–113)	1.7	12.8	1987
Kansas State University Ion Collision Physics Facility (85–ER–403)	1.2	5.0	1988
Nuetron Scattering Experimental Halls, LANL (87–R–403)	5.0	17.5	1989
General plant projects (87–R–400)	4.1	4.1	1988
Accelerator improvements and modifications project	2.9	2.9	1986
1–2 GeV synchrotron source (87–R–406)	1.5	1.5	(1)
Total	$29.5		

[1] AE and Long Lead Procurements.

The CAM Project consists of two buildings: a Surface Science and Catalysis Laboratory which will provide state-of-the-art instrumentation and facilities and the Advanced Materials Laboratory which will be devoted to interdisciplinary study of the synthesis and characterization of energy-related high technology and strategic materials. Both of these facilities will be based on strong programs that exist at the Lawrence Berkeley Laboratory. The FY 1987 budget includes $10.5 million for this project.

At NSLS, $2.6 million is requested in FY 1987. This funding completes the project and will meet the demands for a much higher level usage by providing additional experimental equipment and space. When fully instrumented, the NSLS facility will be able to accommodate 90 experiments simultaneously.

For the SSRL, the FY 1987 request is $1.7 million to complete the project. This funding will allow us to continue three principal items: the construction of two conventional beam lines and three special beam line facilities as well as the alteration of the electron storage ring. These improvements will ensure the usefulness of this facility for basic research for many years to come.

Another major project proposed for final funding in FY 1987 is the Kansas State University Ion Collision Physics Facility; $1.2 million is requested for this project. This facility, which is jointly funded by the University and DOE, will allow researchers to study the atomic physics of a range of ions unmatched in the world.

The budget also includes $5.0 million for continuing the Neutron Scattering Experimental Hall project at LANL, which was begun in FY 1986. As a result of this project, a significant enhancement in research space will be made available to take advantage of the unique (highest neutron-flux in the world) capability at this facility. Construction funds are requested also for General Plant Projects and Accelerator Improvement and Modifications Projects. For these two construction items, the FY 1987 request is $4.1 million and $2.9 million, respectively.

The final project for which FY 1987 funding is requested is $1.5 million for A–E and long-lead procurement for the 1–2 GeV Synchrotron Source. This facility, as I mentioned earlier, is a state-of-the-art synchrotron source which is a necessary step in keeping the U.S. at the cutting edge of technology in the next century.

The budget request for Program Direction provides for personnel and other costs associated with continuation of 63 full-time equivalents.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

The BER program has two main goals: (1) to develop the knowledge base and scientific principles necessary to identify, understand and anticipate the long-term health and environmental consequences of energy use and development; and (2) to utilize the Department's unique scientific and technological capabilities to address major scientific problems in medicine and biology. The FY 1987 budget request will support a program of fundamental and applied research of the highest quality that aims at these goals, and that, at the same time, will continue to contribute to the Nation's economic growth and well-being.

The principal strategy for meeting the first goal has been the development of a long-term research program that is quantitative and mechanistic in its level of understanding, and comprehensive and multidisciplinary in its scope. The need for a strategy with these particular elements is tightly coupled to the mission of the Department. Long-range, quantitative research is dictated by the requirement for broadly generalizable knowledge from which predictive principles can be formulated. Predictive principles permit assessment of energy strategies before they are adopted. They contribute to the health of the Nation by providing the ability to avoid unacceptable impacts prior to, rather than subsequent to, their occurrence; they strengthen the economy by giving us the means to avert major economic stress associated with abrupt discontinuities in energy programs; and they allow us to optimize approaches to mitigating past mistakes. In short, predictive principles provide the basis for rational planning and allocation of resources, and for minimizing adverse health and environmental impacts on future generations as well as on our own.

The comprehensive and multidisciplinary nature of the BER program is unique to the Nation, and arises as a natural consequence of the mission and capabilities of the Department of Energy. Predicting the health impacts of current or anticipated energy strategies requires understanding the health effects of the products of these strategies. But it also requires an understanding of the physics and chemistry of transport and transformation of energy byproducts in terrestrial, marine and atmospheric environments, as they move from source to receptor. A comprehensive approach to the problem clearly requires the type of interdisciplinary strength and coordinated effort for which the National laboratories are so well known. In the case of the environmental research program, these intellectual strengths are complemented by extraordinary field-study capabilities offered by the National Environmental Research Parks.

Because of the unusual characteristics of the BER program and the unique strengths which the Department can bring to bear on major life science problems, the program has spawned scientific and technological discoveries whose implications have far exceeded original programmatic goals. The wide-ranging implications of these accomplishments can be conveyed by a few brief examples.

Basic research, sponsored by the health effects program, aimed at understanding the mechanisms by which radiation interacts with, and damages, biological molecules led to the discovery of repair enzymes. Subsequent research has provided major insights into the genetic determinants of susceptibility and resistance to disease in general, and in particular, it has led to the discovery that certain types of cancer are strongly associated with repair enzyme deficiencies.

Similarly, the program in atmospheric physics and chemistry, which began in the early 1950's in response to a need for understanding the movement of radionuclides through the atmosphere, has turned out to be central to approaching problems such as acid rain, and to understanding the causes and effects of changes in the atmospheric concentration of carbon dioxide and other "greenhouse molecules".

Finally, in the area of measurement science, the cell sorter was originally developed to separate radiation damaged cells from normal cells. Today it is routinely used for performing complete blood counts, for detecting cancer and monitoring its treatment, and for detecting genetic abnormalities. More recent improvements have permitted the development of a chromosome-specific DNA library which is expected to have a major impact on the field of human genetics. Since flow cytometry is now a standard analytical technique in cell biology, its full impact is difficult to summarize, but many scientists consider it perhaps the single most important analytical advance in the history of cell biology.

The scientific and economic implications of these contributions and many others like them have been analyzed recently and will be available for distribution in mid-1986; our best estimates indicate that on the basis of economic impact alone, the public's investment in the BER program and the programs that preceded it has been returned manyfold.

The second goal of the BER program (i.e., to utilize the Department's unique scientific and technological capabilities to address major scientific problems in medicine and biology) had its origin in the 1947 mandate from Congress to utilize advances in nuclear science for the treatment of human disease. At the time the mandate was written, even the most farsighted scientists and legislators would have had difficulty predicting the enormous contributions that the large multiuser facilities and their associated intellectual and advanced technological capabilities could bring to a wide range of problems, not just in medicine, but in basic biology as well. The significance of the latter is embodied in the burgeoning of biotechnology. As I will indicate below, the intellectual tools and resources for research breakthroughs needed by the private sector for applications in the coming decades, exist today, in their most powerful configuration, in the National laboratories.

Historically, the focus of this research has been on nuclear medicine—the development and application of non-invasive imaging techniques, the production of isotopes for the study of metabolic and other kinetic processes, and the production of radiopharmaceuticals for the treatment of cancer and other diseases. These advances have cured or alleviated the sufferings of tens of millions of people throughout the world, and have spawned industries with markets valued at hundreds of millions of dollars per year. More recently, another non-invasive imaging technique, non-nuclear in nature, has been developed. This method, called magnetoencephalography, measures changes in magnetic fields generated by the firing of neurons, and offers great promise for major progress in our understanding of neurological processes. In the future, the scope of this research endeavor will broaden considerably, to take full advantage of the unique capabilities of the Department's laboratories for helping to solve the Nation's major medical and biological problems.

FISCAL YEAR 1987 BIOLOGICAL AND ENVIRONMENTAL RESEARCH BUDGET REQUEST

The FY 1987 budget request for the BER program is $196.6 million. Within this request, $184.6 million is for Operating Expenses; $8.5 million is for Capital Equipment, and $3.5 million is for Construction (Table 9). Funding by research area is shown in Table 10.

TABLE 9.—BIOLOGICAL AND ENVIRONMENTAL RESEARCH

[Budget authority in millions of dollars]

	Fiscal year 1985 Conf. Approp.	Fiscal year 1986		Fiscal year 1987 request
		Conf. Approp.	Adjusted	
Operating Expenses	$177.9	$176.0	$169.4	$184.6
Capital Equipment	7.1	7.8	7.4	8.5
Construction	2.7	3.2	3.1	3.5
Total	187.7	187.0	179.9	196.6

TABLE 10.—BIOLOGICAL AND ENVIRONMENTAL RESEARCH

[Budget authority in millions of dollars]

	Fiscal year 1985 Conf. Approp.	Fiscal year 1986		Fiscal year 1987 request
		Conf. Approp.	Adjusted	
Late effects on health & environment of energy development and use:				
Source and dose determination	$15.6	$15.3	$14.8	$16.6
Environmental processes & effects	32.4	31.1	29.9	32.9
Health effects	63.4	59.9	57.7	65.9
General life sciences	28.5	29.1	28.0	29.9
Nuclear medicine	21.3	24.2	23.3	22.1
Carbon dioxide research	13.1	13.1	12.6	13.6
Program direction	3.5	3.3	3.1	3.6
Facility operations	9.9	11.0	10.5	12.0
Total	187.7	187.0	179.9	196.6

In order to meet its first goal (i.e., to develop the knowledge base and scientific principles necessary to identify, understand and anticipate the long-term health and environmental consequences of energy use and development), the BER program supports four major research areas. These areas are: Source and Dose Determination; Environmental Processes and Effects; Health Effects; and General Life Sciences.

The Source and Dose Determination research program, with an FY 1987 Operating Expenses request of $16.6 million, develops methods and procedures for qualitative and quantitative characterization of radiation and toxic chemicals to which human or ecological populations are exposed. This is the initial step necessary in estimating consequent health effects. Analytical studies are pursued to define the chemical and physical nature of the source. Dosimetry research aims at improving methods for the direct determination of human exposure.

Research in measurement science develops the advanced instrumentation required to pursue effectively the broad scope of the health and environmental effects research program. Progress on many of the problems that must be solved for assessing health and environmental impacts is heavily dependent on advances in measurement science for precise monitoring and diagnosis. The development of new techniques such as remote fiber fluorimetry permit the possibility for chemical monitoring in hostile or inaccessible environments. This particular method is expected to be applicable to problems ranging from in vivo measurements to assessments of ground water contamination. Another method under development, fluorescence line narrowing spectroscopy (FLNS), can distinguish isomers of polycyclic aromatic hydrocarbons. The significance of this is that structurally identical isomers that bind to DNA differ considerably in their carcinogenic activity. FLNS is sensitive enough to detect one such molecule in 100 million DNA bases. Further developments in this and similar methodologies will permit the identification of individuals that have been exposed to potential carcinogenic substances, well before irreversible cell transformation occurs. Continued developments in measurement science are expected to yield methods that permit measurements of previously undetectable concentrations of harmful molecules, or of in vivo markers signalling disease onset well in advance of clinical symptoms.

Taking advantage of the data and insights generated by the Source and Dose Determination activity, the Environmental Processes and Effects research area, with a FY 1987 budget request of $32.9 million in Operating Expenses, focuses on the pathways and mechanisms by which energy-related substances move through the environment, and on the ways that the environment itself may be affected by such substances.

The main atmospheric research programs are PRECP (Processing of Emissions by Clouds and Precipitation) and ASCOT (Atmospheric Studies in Complex Terrain). The goal of the first program is to develop a quantitative understanding of the physical and chemical processes responsible for the incorporation and transformation ("processing") of atmospheric pollutants into clouds and storms, and for the removal of these pollutants by precipitation. ASCOT aims at the improvement of fundamental knowledge concerning the processes that are responsible for the dispersion of atmospheric pollutants over complex (e.g., mountainous) terrain.

The PRECP program has completed three large field experiments investigating the removal of pollutants by precipitation by some typical storm types. The information gathered from surface and aircraft measurements in these storms, together with laboratory simulations and diagnostic modeling, have validated hypotheses which are central to national concerns such as the understanding and control of "acid rain".

In ASCOT, three-dimensional models have been developed of the turbulent flows over western mountain-valley systems, which have been tested in seven field campaigns in four states. These and other models developed in this program are directly applicable to emergency response planning and other Departmental concerns.

Research conducted in the marine program on cycling and movement of energy materials off our coasts is providing crucial information for decisions on appropriateness for ocean disposal of atmospheric and terrestrial energy discharges. Since substances move from disposal sites to distant locations, knowledge of where they migrate to and their rates of migration are crucial to making informed choices for disposal sites.

In the terrestrial system, prediction of the distribution and fate of energy-related molecules such as hydrocarbons requires an understanding of the chemical and physical processes that control and affect the transport of chemical compounds in the subsurface environment. A number of new techniques and methods are being developed which will enable us to predict the movement of materials in ground water and their potential infiltration into aquifers used to provide water for human

consumption. Since movement depends on soil properties, principles and techniques, along with knowledge of soil characteristics at different DOE sites, will enable us to establish a rational scientifically based set of priorities for cleanup.

Energy production and development can affect water use and produce varying degrees of landscape disturbance. Prediction and mitigation of these impacts can be successful only if basic processes affecting ecosystem functioning are well understood. Past research conducted under this program has elucidated the sulfur cycle in forested ecosystems and is now providing crucial information on acid rain. Information on carbon cycling developed with support of this program is now a central part of the evaluation of CO_2 buildup.

Research in physiologic ecology includes studies on a basic understanding of the mechanisms of stress and tolerance in marine organisms exposed to contaminants. Our research has shown that in response to heavy metal contaminants, animals synthesize specific proteins (metallothioneins) which bind and sequester metals in the animal, thus, decreasing metal mobility and effects. Companion studies with host-specific intracellular pathogens are being used to investigate the effects of heavy metals on the synthesis of immune proteins which mitigate disease processes. The results of these studies are being used to predict the ecological effects of energy-related contaminants on valued marine species.

The FY 1987 Operating Expenses request for the health effects research area is $65.9 million. Recent information indicates that the potential exposures to radon gas and its daughter products in residential structures, and the number of people so exposed, may be substantial. The formulation of a rational strategy for the abatement of the risk, requires the entire spectrum of activities sponsored by the BER program. Thus, fully addressing the issue of radon health effects will not only require the development and testing of models of radon transport through the environment, but also carefully controlled epidemiological studies and fundamental studies of the mechanisms by which radon produces injury.

The epidemiologic research program comprises studies that provide needed scientific data and, at the same time, provide information of important practical significance. These studies include investigations of human populations with occupational or environmental exposure to energy-related pollutants. Among the major populations which have been under study for several years are DOE workers/DOE contractor workers, Japanese atomic-bomb survivors, nuclear shipyard workers, and New Mexico uranium miners. These population studies will be supplemented by studies of lung cancer cases in communities located near DOE facilities.

During FY 1987, the results of the nuclear shipyard study will become available. These results will greatly refine our confidence in low-level radiation risk estimates which have been developed through extrapolation from populations exposed at high doses and dose rates. The intensive effort to characterize the industrial hygiene aspects of these facilities in order to identify chemical hazards which may be responsible for some apparently deleterious health effects that have been discovered in previous epidemiologic investigations will continue.

The experimental health effects research program uses laboratory-based studies and a multispecies approach to make predictive correlations between cellular/molecular events and whole animal responses, and between laboratory animals and humans. The discovery that DNA damaged by radiation and chemicals could be repaired was a landmark achievement. High priority will be given to the molecular biology of the enzymes that repair damaged DNA and to the genes that control these enzymes. More generally, increased emphasis will be placed on molecular epidemiology including identification of molecular markers for susceptibility and resistance to chemical and radiation damage. Studies will also be made to identify populations that may be especially susceptible to energy byproducts so their needs and concerns can be met early. Research on cancer-related genes, oncogenes, that are activated by radiation and other energy-related materials, will be expanded, and relations will be sought to link them to current DOE-supported epidemiologic studies of cancer in human and animal populations.

The majority of exposures of people to hazardous material is not to single materials but to complex mixtures of chemicals and perhaps even to radiation and chemicals together. Studies of complex mixtures show that their health effects cannot always be predicted by adding the effects of isolated components. To understand this problem a complex mixture program has been initiated to develop predictive principles of toxicity and mutagenicity.

Another major problem is to determine the extent to which radiation and chemical damage to genetic material is transmitted to future generations. This problem is of extraordinary importance since it bears directly on the question of whether decisions made today will effect the burden of disease of future generations. To develcp

a basis for answering these questions, new molecular approaches will be developed for studying the hereditibility of certain types of molecular, chromosomal and genomic damage.

Research in General Life Sciences, for which $29.9 million in Operating Expenses is requested in FY 1987, provides the fundamental basis of the entire BER program. This research extends our base of biological information and develops concepts to allow the fullest understanding of the health effects of various energy options.

Research in cell biology will be supported to understand the normal processes of cells, their functions and their regulation. An important problem is to understand the factors influencing cell stability and malignant transformation.

Research in molecular biology will focus on the structure and function of the gene at the molecular and chromosomal levels, the arrangement of genes in chromosomes, and how this arrangement affects the way genes are expressed and regulated.

Studies in structural biology will use the special facilities developed by the Department for the analysis of macromolecular structure. Use of the intense neutron beams produced by nuclear reactors and accelerators and the synchrotron light produced by its electron storage rings will permit information to be obtained faster and under more realistic conditions than was previously possible. These experimental capabilities, the Department's powerful computer network, and its unique breadth and depth in the mathematical sciences will lead to new and far more rapid approaches to determining and predicting molecular structure. Progress in this area will have a major impact on the future of biotechnology including protein engineering, and drug and vaccine design.

The second major goal of the BER program is the utilization of the Department's unique scientific and technological capabilities to address major problems in medicine and biology. The development of applications in the field of nuclear medicine has historically been the major program associated with this goal.

The budget request for the FY 1987 Nuclear Medicine Applications program is $22.1 million. Its objective is to continue the development of new nuclear medicine procedures through the production of new radionuclides, the radiolabeling of new biologically active agents, and advancements in instrumentation. Efforts to develop other medical applications using reactors, accelerators and other related nuclear technologies for the treatment of cancer will be maintained.

Recent developments in the BER nuclear medicine program have produced new radiopharmaceuticals labeled with short-lived radionuclides. In syntheses involving the most important positron emitting radionuclides (oxygen-15, 2 minute half life; nitrogen-13 10 minute half life, carbon-11, 20 minute half life, and fluorine-18, 110 minute half life), one cannot use standard techniques. Rather, innovative rapid organo- and biosynthetic techniques must be developed using the technologies or molecular biology, biochemistry, organic chemistry, hot atom chemistry and radiochemistry.

The new short-lived radionuclide labeled radiopharmaceuticals are proving to be useful in studies of the metabolic functions of the brain and heart. Major advances have been made to date in quantitating physiology and pathophysiology in the human brain and heart utilizing Positron Emission Tomography. Continued development of advanced tomographic systems will have immediate medical implications in evaluation of stroke patients and diagnosis of degenerative brain disorders such as Alzheimer's, Huntington's and Parkinson's disease.

In FY 1987, research and development will be maintained and devoted to identifying and optimizing techniques for attaching radionuclides to monoclonal antibodies. These homogeneous populations of molecules recognize characteristics which are peculiar to cancer cells. They, therefore, offer the potential for early detection of cancer, for following the response of patients to treatment, and for general cancer therapy. A substantial research and development effort will be required to perfect and evaluate techniques for using labeled monoclonal antibodies. It is anticipated that by FY 1987 work on monoclonal antibodies for cancer therapy will have progressed to the point that one or more of these agents will have been identified as having sufficient potential for clinical trials. In addition, the monoclonal antibody work will be extended to labeling with radionuclides suitable for positron tomographic diagnostic imaging.

The use of magnetic resonance imaging (MRI) spectroscopy to detect carbon-13 and nitrogen-15 labeled metabolic products within intact tissues and cells holds exceptional promise in providing new insight into the mechanisms responsible for metabolic regulation. Because of the great importance of heart disease, current research efforts are focused on the identification of the metabolic effects in the perfused heart model of several proposed therapeutic strategies for treatment of ischemic

heart disease. Efforts will be concentrated on obtaining quantitative measurements of metabolic concentrations in the heart.

The Carbon Dioxide Research FY 1987 Operating Request is $13.6 million. Its goal is to develop a sound, quantitative atmospheric carbon dioxide knowledge base to aid in energy policy decisionmaking. It is the position of the Department of Energy that we do not yet have the scientific data base needed to recommend specific, firm energy policy options for consideration of the Congress relating to CO_2 potential impacts.

Based on projections of potential global impacts, we believe we have the time in which to conduct the research necessary to improve estimates of future atmospheric CO_2 which will include better estimates of energy usage and the workings of the carbon cycle, and improve climate modeling to develop regional and seasonal climate estimates as a function of future atmospheric CO_2. These are prime research directions. Because oceans play a major role in the exchange of carbon dioxide with the atmosphere and as a heat engine in relation to global climatic conditions, much more data, analysis and modeling of oceans is required to be able to develop climate and carbon cycle models with which to predict effects of elevated increased atmospheric CO_2 levels. Although improved understanding of the direct effect of elevated CO_2 on crops is beginning to emerge, it is necessary to design experimental methods to determine the first principles which integrate crops, weeds and insects so that an ecological systems model can be developed. Collaborative international research is a necessity if CO_2 research is to be successful, and, to this end, we are working with many international groups and individuals (e.g., PRC, Australia, Switzerland, Canada).

In FY 1986, State-of-the-Art Reports were published on four major components of the Carbon Dioxide Research Program which indicate what we know or do not know, and which identify the key uncertainties in our knowledge and recommend research activities. We intend to vigorously pursue the recommendations of these definitive statements to reduce the current uncertainties in the scientific knowledge base to a level required for effective decisionmaking.

The FY 1987 budget request for Facility Operations is $ 12.0 million. These funds provide for the necessary capital equipment and general plant project needs to support the BER program and its Pacific Northwest Laboratory landlord responsibilities.

The Capital Equipment request of $8.5 million for FY 1987 is essential for acquiring state-of-the-art equipment, replacement of deterioriated and obsolete instrumentation, and general purpose equipment needs at the Pacific Northwest Laboratory.

The Construction request for FY 1987 is $3.5 million. The request supports the program's General Plant Project needs, and the Pacific Northwest Laboratory landlord responsibility. General Plant Projects are necessary to accommodate continuing requirements to maintain satisfactory and economic operating conditions, to meet regulatory requirements and to provide for new program developments.

The FY 1987 request for Program Direction is $3.6 million. These funds are required to provide for the personnel costs of 53 fulltime equivalents to direct, manage, and support these multidisciplinary research efforts.

This completes my summary of the BER program. I would now like to discuss the several ER outlay programs that are related to my statutory responsibilities to advise the Secretary on DOE energy R&D programs, the non-weapons multiprogram laboratories, and the education and training of scientists and engineers.

ADVISORY AND ASSESSMENT ACTIVITIES

Within the Office of Energy Research, the Office of Field Operations Management (FOM) and the Office of Program Analysis (OPA) support the Director's statutory advisory responsibilities. The Office of Field Operations Management provides support with regard to management oversight of the laboratories and energy-related manpower development and training activities of the Department. The Office has developed policies and several management tools that the Department uses to administer its laboratories and R&D facilities across the country. The office also manages the University Research Support, the University Research Instrumentation, and the Multiprogram Energy Laboratories-Facilities Support programs, each of which I will discuss shortly. The Energy Research Analysis program, managed by the Office of Program Analysis, on the other hand, provides independent and objective program analyses and technical assessments.

ENERGY RESEARCH ANALYSIS

The Energy Research Analysis (ERA) program is the only Departmental program specifically designed to provide independent technical assessments of DOE programs. One of the program's principal tasks is to solicit and obtain credible judgments by premier researchers and expert scientists of the quality of DOE-supported science and its eventual impact. Often following from these judgments are recommendations on the necessary next steps for the research. These recommendations provide independent views on future program directions for DOE program managers to consider. This method of technical review has evolved over the past 5 years with participation by several hundred industry, academic, and laboratory researchers.

Recent accomplishments include technology assessments of fuel cell research, wind turbodynamics, nonhighway transportation, and light water reactor automation. A comprehensive review of the low level radioactive waste technologies was also accomplished resulting in recommendations for future research and development. A program assessment of the Oak Ridge National Laboratory's exploratory fund program, which reflects a broadly supportive program for new and innovative research ideas, is ready for publication.

The success of this exploratory fund program is one of the reasons for my support of such activities.

In the area of acid rain, the Office of Program Analysis continues to represent DOE on the Interagency Task Force on Acid Precipitation. This Task Force plans, coordinates, assesses and establishes the budgets for all Federal acid rain research. Peer reviews of the research into materials damage caused by acid rain have been held recently, resulting in directions for future research to clearly establish any deleterious effects of acid rain. These and other assessments are focusing on 1987 as a key year for identifying and quantifying acid rain impacts. The Energy Research Analysis program has been instrumental in bringing research to bear on this and similar issues. In addition, a National Laboratory Consortium mandated by the Energy Security Act of 1980 (P.L. 96–294) (ESA), composed of four National laboratories (Brookhaven, Argonne, Pacific Northwest, and Oak Ridge), is carrying out the comprehensive multi-year research effort provided for under section 704 of ESA to explain the impacts of acid rain, in addition to their roles as Task Force members.

The FY 1987 budget request for the Energy Research Analysis program is $3.5 million. It provides for (1) one to two independent analyses of the accomplishments of DOE R&D programs, (2) two to three assessments of technologies, (3) support for assessment and coordination elements within the National Acid Precipitation Assessment Program (NAPAP), including DOE's share of the support for the NAPAP Director of Research, (4) support of groups such as the Energy Research Advisory Board (ERAB) and JASON, and (5) technical support on issue papers and alternative action studies.

UNIVERSITY RESEARCH SUPPORT

The goal of the University Research Support (URS) program is to help maintain strong scientific/technical research capabilities in support of the Department's long-range energy R&D mission. To accomplish this goal, the URS program provides a special Departmental focus for a number of efforts which primarily involve universities and university faculty and students, both directly and in conjunction with the Department's National laboratories. The goals of these interrelated efforts are to:

Maintain and strengthen university-based energy research and manpower development capabilities in selected high priority energy research fields.

Use the unique resources of the National laboratories (equipment, instrumentation and personnel) to assist in university faculty and student research manpower development.

Assist in the transfer of laboratory-developed technology and expertise to the university and private sector.

Increase the number and enhance the quality of students, including women and minorities, pursuing professional level degrees in energy-related science and engineering.

Help strengthen the scientific/technical workforce in the Department's National laboratories.

With an FY 1987 budget request of $11.0 million in Operating Expenses, the URS program consists of two major subprograms (Table 11). The first of these is the University/Laboratory Research subprogram, with a FY 1987 Operating Expenses budget request of $9.7 million. This subprogram supports both the University/Laboratory Cooperative Research and University Reactor Fuel Assistance efforts. One of the objectives of the Laboratory Cooperative Research activity is to enhance the

quality of students pursuing future careers in science or engineering by involving them in ongoing laboratory research programs. This approach offers the added benefit of making additional research capabilities available to participating university faculty. The second subprogram is Energy Manpower Development with an FY 1987 Operating Expenses request of $1.3 million. This subprogram combines two manpower-oriented activities. The Manpower Assessment activity conducts assessments and analyses of the supply and demand of manpower for both current and future energy R&D programs. The Energy Education and Training activity supports projects directed at encouraging secondary school students to pursue energy-related science and engineering programs at the college level.

TABLE 11.—UNIVERSITY RESEARCH SUPPORT

[Budget authority in millions of dollars]

Operating expenses	Fiscal year 1985 Conf. approp.	Fiscal year 1986		Fiscal year 1987 Request
		Conf. Approp.	Adjusted	
University laboratory research:				
University laboratory cooperative research	$6.5	$6.0	$5.8	$7.8
University research fuel assistance	2.8	3.9	3.7	1.9
Subtotal	9.3	9.9	9.5	9.7
Energy manpower development:				
Energy manpower assessment	0.5	0.4	0.4	0.5
Energy education and training	0.3	0.4	0.4	0.8
Subtotal	0.8	0.8	0.8	1.3
Total university research support	10.1	10.7	10.3	11.0

The FY 1987 budget request for the URS program specifically includes: (1) support for approximately 2500 student and faculty research participation appointments and special training appointments at the Department's labs and major contractors; (2) support for joint research and manpower development efforts involving the DOE laboratories and Historically Black Colleges and Universities; (3) support for 20 Pre-freshman Engineering Program Projects that will reach over 2500 junior and senior high school students, and for high school science student institutes at selected DOE laboratories; (4) cost-shared support for 30 visiting industrial scientists through the joint DOE National Laboratory Industry Technology Transfer Exchange Research Program; (5) updated manpower assessments for future professional level manpower requirements (e.g., scientists and engineers) for DOE research programs; and (6) refueling of 7 university reactors and approximately 20 reactor sharing grants to be made on a competitive basis. This latter activity falls under the University Reactor Fuel Assistance Program which provides fuel for university research and training reactors. The national nuclear reactor and manpower development effort is highly dependent on these specialized facilities not only for nuclear-related training but also for research in the basic sciences.

UNIVERSITY RESEARCH INSTRUMENTATION

Direct access to state-of-the-art scientific research instrumentation equipment is essential for continued progress in advanced, energy-related scientific and technical research. For example, frontier-level materials research in surface science and catalysis requires the ability to describe what is occuring at atomic and molecular levels. This research is essential for understanding such phenomena as carbon gasification, and the composition of surface gases. Instruments used in this research must be able to detect and indentify materials at the parts per billion level.

Another example is in the field of biological energy research where a major limitation is in understanding the key proteins which influence physiological and genetic factors related to plant productivity. Advances in the analytical capacity of mass spectrometry now offer biological scientists possibilities for approaching this problem.

Many university scientists do not have direct access to sophisticated, state-of-the-art scientific research instrumentation. This is a serious national problem which is being addressed through the combined efforts of Federal science agencies, state gov-

ernments, private industry and by the university community itself. The Federal effort is coordinated by the Office of Science and Technology Policy through the Interagency Committee on University Research Instrumentation chaired by the Deputy Director of the National Science Foundation. Each participating Federal agency is responsible for supporting university research instrumentation in relating to agency missions and programmatic needs. The DOE response to this overall national effort is the University Research Instrumentation Program initiated in FY 1984 to help support the purchase on a competitive basis by university researchers of state-of-the-art instrumentation.

The FY 1987 request for the University Research Instrumentation Program is $5.0 million. This level will support an estimated 15 to 18 competitively selected awards for instrumentation costing over $100,000. Typical instruments supported in prior years include microprobes, electron and scanning microscopes, laser systems and spectrometers. As in prior years, the program will concentrate on those university research groups which have already demonstrated expertise in one of a small number of higher priority energy-related topics which are of special concern to the Department's research programs. Among the research topics to be considered in FY 1987 are catalysis, bioconversion, engineering research including materials, the geological sciences, and environmental research. Each award will be cost-shared with the selected university.

MULTIPROGRAM ENERGY LABORATORIES-FACILITIES SUPPORT

The FY 1987 request for the Multiprogram Energy Laboratories-Facilities Support (MEL–FS) program is $60.2 million (Table 12). The MEL–FS program consists of two subprograms: Multiprogram Energy Laboratories-General Purpose Facilities (MEL–GPF), initiated in FY 1981, and Environmental Compliance, initiated in FY 1985. The goal of the MEL–GPF subprogram which is managed for the Department by the Office of Energy Research, is to rehabilitate and replace multiprogram general support facilities that are essential to continued operations of the Department's multiprogram laboratory sites. These support facilities include site utilities and support buildings such as laboratories, office buildings and warehouses, road and railroads, which represent a multibillion dollar Government investment.

TABLE 12.— MULTIPROGRAM ENERGY LABORATORIES-FACILITIES SUPPORT

[Budget authority in millions of dollars]

Operating expenses	Fiscal year 1985 conf. approp.	Fiscal year 1986		Fiscal year 1987 request
		Conf. approp.	Adjusted	
Environmental compliance	0	$10.4	$9.3	$14.3
Capital Equipment: Environmental compliance	0	1.0	1.0	1.0
Construction:				
Multiprogram energy general purpose facilities	33.2	23.7	22.8	34.9
Environmental compliance	0	7.0	6.7	10.0
Total MEL–FS	[1] 33.2	42.1	39.8	60.2

[1] A reprogramming approved in April 1985, transferred $5.4 million to this activity.

Through continued use and aging, support facilities deteriorate to a point where they are no longer capable of performing their intended functions and must be rehabilitated or replaced. The MEL-GPF program systematically reduces the backlog of deficiencies of these support facilities. It reflects an appropriate Federal responsibility for management of the Government's real property, and we plan to continue the program as a necessary cost of doing business as long as the multiprogram laboratory facilities are used to perform research and development functions for the Department.

The FY 1987 Construction budget request for MEL–GPF is $34.9 million (Table 13) and would continue construction on projects begun in prior years, including chilled water facilities at Brookhaven, Oak Ridge and Argonne National Laboratories, replacement of laboratory roofs at Argonne National Laboratory, a fire alarm system at Richland, and fire protection improvements at Brookhaven.

TABLE 13.—MULTIPROGRAM ENERGY LABORATORIES—GENERAL PURPOSE FACILITIES [MEL-GPF]

[Budget authority in millions of dollars]

Construction	TEC	Fiscal year 1987 Request
New projects:		
Buildings:		
Laboratory restoration I, PNL (87-R-751)	$2.1	$2.1
Piping system restoration, ORNL (87-R-752)	3.8	0.7
Rehabilitate, laboratory space (87-R-753) (building 200), ANL	12.0	1.2
Utilities		
Mechanical systems rehabilitation, ANL (87-R-755)	3.2	1.1
Waterline replacement, ANL (87-R-756)	5.2	1.0
Electrical system rehabilitation, LBL (87-R-757)	2.6	0.3
Rehabilitate mechanical utilities, LBL (87-R-758)	5.5	1.1
Upgrade steam distribution system, ORNL (87-R-759)	6.8	2.0
Subtotal new projects	-	9.5
Prior year ongoing projects:		
Fire protection improvement, BNL (86-R-726)	3.0	2.5
Central chilled water facility, BNL (85-R-701)	15.0	5.7
Replace laboratory roofs, ANL (86-R-702)	9.8	2.4
Electrical distribution system restoration, ORNL (85-R-703)	2.2	1.4
Medical facility replacement, LLNL (85-R-706)	7.3	4.0
Replace site fire alarm system, RL (85-R-707)	4.8	1.2
Establish a central chilled water plant, ANL (85-R-709)	5.2	3.6
Modify central chilled water plant, ORNL (85-R-712)	4.7	2.6
Road repairs, RL, LBL, INEL, ANL (85-ER-103)	19.2	2.0
Subtotal ongoing projects		25.4
Total multiprogram energy laboratories—general purpose facilities		34.9

The FY 1987 request includes eight new projects including laboratory restoration at Pacific Northwest Laboratory, piping system restoration and steam distribution system upgrade at Oak Ridge National Laboratory, rehabilitation of laboratory space and waterline replacement at Argonne National Laboratory, mechanical systems rehabilitation at Argonne and Lawrence Berkeley Laboratories and electrical system rehabilitation at Argonne National Laboratory.

Environmental Compliance is a separate subprogram because of the magnitude of the requirements at Oak Ridge National Laboratory. As such, it will identify and correct deficiencies at ORNL to ensure compliance with existing state and Federal regulations. Over the years, ORNL has generated a variety of radioactive and nonradioactive pollutants which were handled in accordance with existing environmental regulations. Since that time, a number of new regulatory requirements have resulted in the application of more stringent environmental criteria. As a result, long-established procedures and approaches to handling hazardous wastes are no longer acceptable.

The Department is currently working to fully determine the actions necessary to bring ORNL into compliance with all applicable regulations. The Environmental Compliance FY 1987 budget request of $25.3 million will allow initiation of activities to correct environmental deficiencies at ORNL. The Operating Expenses request of $14.3 million will allow initial activities in the following areas: process waste system upgrades, hazardous and toxic material management improvements; characterization of hazardous and radioactive wastes; determination of potential for ground water contamination in spill sites, holding ponds and White Oak Creek watershed; and upgrades of sanitary and storm sewers. The Capital Equipment request of $1.0 million is for General Plant Projects (e.g., upgrade of the process waste collection system; groundwater monitoring network, etc.) and $7.0 million is for the Non-radiological Process Waste Treatment Project.

ADVISORY AND OVERSIGHT PROGRAM DIRECTION AND POLICY AND MANAGEMENT

The FY 1987 budget request for Advisory and Oversight Program Direction is $2.9 million. The FY 1987 request will provide the staffing resources required by the Di-

rector of Energy Research to carry out his responsibilities under legislation (P.L. 95–91) and those assigned or delegated by the Secretary in areas beyond the scope of other ongoing Energy Research programs. These funds are required to provide for the salaries, benefits, travel and other expenses associated with 44 full-time equivalents.

The FY 1987 budget request for Policy and Management is $0.5 million. These funds are required to provide for the salaries and related expenses associated with 8 full-time equivalents in the Office of the Director of Energy Research.

Mr. Chairman, that concludes my testimony. I would be happy to answer any questions.

Biographical Sketch of Alvin W. Trivelpiece

Dr. Alvin W. Trivelpiece was nominated by the President on July 8, 1981, and confirmed by the Senate on July 27, 1981, as Director of the Office of Energy Research, U.S. Department of Energy (DOE). In this position, Dr. Trivelpiece serves as technical adviser to the Secretary of the Department's energy research and development programs and is responsible for the multipurpose laboratories and energy education and training activities. In addition, he manages DOE's programs for basic energy research, health and environmental research, high energy and nuclear physics, and magnetic fusion.

Dr. Trivelpiece has extensive experience in the areas of plasma physics and fusion research. From 1978 until assuming his current position, Dr. Trivelpiece was Corporate Vice President of Science Applications, Inc., of La Jolla, California, primarily responsible for internal research programs relative to innovative technical developments. From 1976 to 1978, he was Vice President for Engineering and Research at Maxwell Laboratories, San Diego, California.

During the period 1973 to 1975, Dr. Trivelpiece served with the U.S. Atomic Energy Commission as Assistant Director for Research in the Division of Controlled Thermonuclear Research. Prior to joining the Federal Government, he was Professor of Physics at the University of Maryland, serving in that capacity from 1966 to 1976. From 1959 to 1966, he was a professor at the University of California at Berkeley in the Department of Electrical Engineering.

He received a B.S. degree from California Polytechnic State University in 1953, an M.S. degree in 1955, and a Ph.D. degree in 1958. Both advanced degrees were awarded by the California Institute of Technology.

The recipient of serveral honors and awards, Dr. Trivelpiece is listed in "American Men and Women of Science," "Who's Who in America," and "Who's Who in the World." He holds several patents in the area of physics research and is the author and coauthor of over 100 technical reports and books. Dr. Trivelpiece is a member of numerous professional organizations and is a Fellow of the American Physical Society, the Institute of Electronics and Electrical Engineers, and the American Association for the Advancement of Science. He has served as a consultant to various private associations and Government agencies and has lectured at conferences and universities throughout the United States and abroad.

Dr. Trivelpiece was born in Stockton, California. He is married and has three children.

THURSDAY, MARCH 6, 1986.

SOLAR AND RENEWABLES, FUSION, AND ENVIRONMENT, SAFETY AND HEALTH

WITNESSES

DONNA FITZPATRICK, ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY

ALVIN W. TRIVELPIECE, DIRECTOR, OFFICE OF ENERGY RESEARCH

MARY L. WALKER, ASSISTANT SECRETARY FOR ENVIRONMENT, SAFETY AND HEALTH

ROBERT L. SAN MARTIN, DEPUTY ASSISTANT SECRETARY FOR RENEWABLE ENERGY

RAYMOND P. BERUBE, DEPUTY DIRECTOR, OFFICE OF ENVIRONMENTAL AUDIT AND COMPLIANCE

GEOFFREY J. JUDGE, ACTING DIRECTOR, BUDGET AND ADMINISTRATION STAFF, ENVIRONMENT, SAFETY AND HEALTH

Mr. BEVILL. Good morning. We are pleased to have each of you here. Donna Fitzpatrick is listed first here. I realize you are of equal rank, but we will give you priority and let you answer all the difficult questions. The chair recognizes you at this time, Miss Fitzpatrick.

OPENING STATEMENT—SOLAR AND RENEWABLES

Miss FITZPATRICK. Thank you, Mr. Chairman.

I have a statement which I would like to submit for the record, and if I may, I would summarize it.

Mr. BEVILL. It will be made part of the record.

Miss FITZPATRICK. I appreciate the opportunity to appear before you today and discuss the FY 1987 request concerning the Department's Renewable Energy and Electric Energy Systems and Energy Storage programs. The budget for these programs is consistent with the goals and objectives of the National Energy Policy Plan and is fully responsive to the Administration and Congressional goals of deficit reduction.

The Administration's overall energy goal is to foster an adequate supply of energy at reasonable cost. Achieving this goal will require that we make full use of our nation's vast natural resources and the ingenuity of its citizens. Deficit reduction is perhaps the preeminent domestic economic imperative today and the Department fully recognizes that. For this reason, we are doing all we can to concentrate increasingly scarce resources on those programs and projects that directly fulfill a responsibility of the Federal Government and truly require federal assistance.

If we are to achieve our overriding goal of deficit reduction, we have no choice but to concentrate scarce resources where they

show promise of bringing the greatest benefits. As we seek ways to gain the greatest benefits from our resources we will investigate cooperative research and development ventures with private industry consortia. This approach to R&D funding has the potential to provide greater leverage for federal funds and more effective technology transfer.

We have had a number of successes in the last year and in order to continue to contribute to the achievement of our goals, our 1987 budget request for renewable energy R&D programs will continue to support development of a mix of technologies that can contribute to both energy supply and improved energy efficiency.

I would like to briefly summarize for you our budget request for the Renewable Energy program. Renewable energy is an important part of the nation's energy supply, and in fact, renewable resources—solar, biofuels, wind machines, hydropower, and geothermal—presently account for more than eight percent of the energy consumed in the United States. In certain locations the contribution is even greater and more progress is being made.

Eight percent of California's new electric generation capacity is now renewable.

When the federally supported renewable energy program began in 1974, most of the technologies were either in the conceptual or very primitive stages. During the past decade major advances have been made in all of the technologies. New materials have been developed with thermal, optical and physical properties which are required for lower cost and higher performance. New components have been tested, extensive systems analysis has been performed; and hundreds of systems have been studied in laboratories and in field conditions.

There are scientists working in government laboratories, universities and industry, who have created a solid technology base and the expertise in the broad array of disciplines pertaining to renewable energy technologies.

As the various technologies continue to develop, their economic and technological viability will improve, along with their collective contribution to our energy needs. In order to support this development, our program will continue to address a range of fundamental issues.

These issues include basic materials-related work on the structural integrity of reflective surfaces, the conversion efficiency of photovoltaic materials, the resolution of wind technology reliability issues, and environmental uncertainty, attendant to the combustion of municipal waste; research in biological health effects and risks associated with exposure to the high-voltage electric and magnetic fields, and the feasibility of using magma energy as a source of power generation.

The proposed budget for renewable programs is $109 million.

Mr. Chairman, I believe that this budget will contribute to increased energy supply diversity and energy efficiency and will serve to promote increased competition in the marketplace. This budget request maintains program goals and will allow us to address the items of highest priority in research and development in the field of renewable energy, thereby, contributing to the accom-

plishment of our national goal of fostering an adequate supply of energy at a reasonable cost.

This is a budget which recognizes our fiscal responsibilities as well as our anticipated needs, and it builds on the foundation of energy stability and security that we, working with the Congress, have laid in the last five years.

Mr. Chairman, we are pleased to have the advice of the Congress and in particular, this subcommittee, and I am prepared to answer any questions you may have today.

[The statement of Miss Fitzpatrick appears at the end of this hearing.]

Mr. BEVILL. Very good.

At this time, the chair recognizes Dr. Trivelpiece.

OPENING STATEMENT—FUSION

Dr. TRIVELPIECE. Thank you, Mr. Chairman.

I am frequently asked when will fusion power be available, and of course, the answer always seems to be in about 20 years. It is even sometimes joked about, this 20 years, as being a fundamental constant of the program. I would like to take this opportunity in the opening remarks to comment on this question in particular.

What was the question that was really asked 20 or 30 years ago when that was the answer? It wasn't really when would we have a fusion driven power plant, but it was rather at that time, since we didn't know very much, could we create, confine and heat a plasma to the right conditions for fusion to occur?

I think the answer to that question is yes. Right now, today, we can design, construct and operate a magnetic plasma confinement system that will create conditions necessary to sustain fusion reactions. So the original question of 20 years ago has, in fact, been answered in the affirmative.

In the meantime, however, an interesting thing has happened. The context of the question, or the implication of the question has in fact shifted from one that implies scientific feasibility to one that implies technological feasibility, and the question really that is being applied now is, now that you can produce the right kind of plasma, how long is it going to take you to develop a device that can make practical energy? The truth is, of course, that indeed could take another 20 years, but that is going to depend a little bit upon the priority that the United States and the other countries choose to put on this particular kind of activity.

In that regard, we have been discussing what the next steps are that might be required to make progress with the other members of the economic summit countries. There is general agreement among this group that an ignition experiment followed by something like an engineering test reactor are the next central steps required to make progress in sort of realizing this goal of technological feasibility.

In that regard, the interest in possible international collaboration on fusion has been stimulated by the recent Geneva summit in which Mr. Reagan and Mr. Gorbachev said that they emphasized the potential importance of work aimed at utilizing controlled thermo-nuclear fusion for peaceful purposes and in this connection

advocated the widest practicable development of international cooperation in obtaining this source of energy which is essentially inexhaustible for all of mankind.

There is a certain issue in all of this, and that is that after all the hard work that has been done by scientists here in the United States and elsewhere around the world to get to this particular point, we find ourselves in the midst of an energy supply situation that has reduced the determination in effect to pursue some of these alternate energy options with the same vigor that we did in the mid-seventies. This situation combined with the budget deficit pressures has resulted in the Administration request for fusion at about $50 million less than the 1986 conference level. This reduction, following the preceding two years of reductions, really couldn't be digested and still have a program that developed all the confinement approaches that might be desirable.

As a result, we have had to eliminate the magnetic mirror program activities. This is not because there are any particular technical problems with that approach or that the scientists and engineers working on it have done anything wrong. Quite the contrary. I believe they have done a superb job in the design and construction of this facility at Livermore, and so it is really unfortunate that budget pressures dictate that we not operate this facility which has just been completed. I would like to, before turning to questions, read into the record the letter that Secretary Herrington addressed to Dr. Fowler, the Director of that laboratory, on this occasion, because I think it summarizes some of the thoughts very well.

"Dear Dr. Fowler:

"First, I want to extend my congratulations to you and your staff for a job well done in the design and construction of the Mirror Fusion Test Facility. The hard work, dedication, and hopes that go into this kind of effort are among the characteristics that make this country great.

"Second, I want all of you to know how much I regret the fact that just as you complete this remarkable new facility, the budget pressures dictate that we must put it into standby and not operate it as you might have hoped. This is frustrating and perhaps not the best use of our national talent and resources, but we must bring the deficit under control. Those of you who are affected by this must feel that this is unfair and that the budget reductions should have been applied elsewhere. Perhaps, but budget reductions were applied elsewhere, and I have tried to see to it that this was done in a fair and equitable manner consistent with the President's goals.

"I hope that the circumstances will change in such a way that this facility can eventually be operated to gain the knowledge it was designed to generate. In the meantime, I know that you will continue to make important contributions to the nation's effort to make fusion energy a practical reality. I am grateful that you have the skills and dedication to do this important work. You have my admiration for what you have done and will do.

"Yours truly,

"John S. Herrington."

Mr. Chairman, that completes my opening remarks. I would be prepared to answer questions.

[The statement of Dr. Trivelpiece appears at the end of this hearing.]

Mr. BEVILL. Secretary Walker.

OPENING STATEMENT—ENVIRONMENT, SAFETY AND HEALTH

Ms. WALKER. Mr. Chairman, and members of the subcommittee, I am pleased to be here today to talk with you about the Department's budget request for fiscal year 1987 for the Environment, Safety and Health program. I believe this budget represents Secretary Herrington's commitment to operating all of our facilities in a safe, environmentally sound manner and also represents implementation of certain key initiatives that he announced in September of 1985 designed to ensure that that is, in fact, the case.

To briefly summarize those, first oversight responsibility for the environment, safety and health function has been consolidated and upgraded under an Assistant Secretaryship. Additional resources are envisioned for the staff and the functions there so that the environment, safety and health functions can be integrally involved in the operations of the Department at all levels and we can more directly oversee corrective actions necessary to be taken in the environmental and safety areas of the Department's ongoing operations.

Second, the Department expects to conduct a baseline Environmental Survey of all of its facilities, making use of existing environmental information, but making complete the picture department-wide so that we can prioritize areas of existing environmental problems and risks, and make wise decisions in the future when we have to look at corrective measures, some of which will, of course, cost a lot of money.

Third, we have currently begun and expect to have ongoing in 1987 technical safety appraisals of all of our high and moderate hazard nuclear facilities that are designed to determine not only compliance with safety requirements, industry lessons learned and license facility requirements, but ensure the continued standard of excellence in the area of safety which we have had in the past.

Fourth, we will establish, or hope to establish, a computer assisted tracking system to monitor compliance and progress in the completion of corrective measures at each facility, so that the Secretary and the departmental managers will have at their fingertips the status of any given facility in terms of its environmental and safety performance, but be able to know exactly what is needed to complete the good picture and to monitor that.

I would be pleased to answer any questions on not only the new initiatives, but the baseline budget for fiscal year 1987.

Thank you.

[The statement of Ms. Walker appears at the end of this hearing.]

OPENING STATEMENT FOR THE RECORD—LGSTF

[The statement of Mr. Bauer appears at the end of the end of this hearing.]

ENVIRONMENT, SAFETY AND HEALTH—COMPUTERIZATION

Mr. BEVILL. Secretary Walker, will you have enough money in the budget to accomplish the computerization you are referring to?

Ms. WALKER. Yes sir, I believe we do.

FUSION PROGRAM—MFTF-B

Mr. BEVILL. Dr. Trivelpiece, this facility you testified about at Livermore concerns me. As I understand the situation, we have invested $350 million, and just as it is finished, we are not going to operate it. Is that what I understood you to say?

Dr. TRIVELPIECE. That is absolutely correct.

Mr. BEVILL. That is hard to understand.

Dr. TRIVELPIECE. It is indeed hard to understand.

Mr. BEVILL. What is going to be the impact of this? What is going to happen to the personnel? It takes highly trained and knowledgeable people to operate it. What is going to happen now?

Dr. TRIVELPIECE. Some of them will be——

Mr. BEVILL. Assuming the committee goes along with the Administration's recommendations?

Dr. TRIVELPIECE. First, some of them would obviously be involved in some of the activities necessary to mothball it and put it into a standby state so that it could be operated at some time in the future should that be desirable or possible. There are some of the activities that the scientists there at the laboratories can do at other institutions and some of them will perhaps work at say the Doublet III experiments in General Atomic San Diego.

We would propose to have probably $6 million worth of support level moved from Livermore into GA, so it would not be lost to the program, but it would appear elsewhere. But the facility itself just goes into standby and we will not operate it, and that is unfortunate.

This facility came into existence in a sense during a period when, as you remember, the Fusion Energy Act of 1980, which many of you were co-sponsors of, dictated that certain plans be carried out, and not to be carried out but certain plans be presented to the Congress to do certain things. This was agreed when the price of oil was high. The supply still looked like it was in some jeopardy, and this activity got started during that period.

Now we have reached a set of conditions in which the price of oil has dropped to some unprecedented lows, and supply seems to be very high, and some of the urgency to do energy things is not as large and the deficit is, and the Department was confronted with having to make some very difficult choices. The Secretary said to you the other day when he testified before this committee, that these are difficult choices.

This is not perhaps the best use of talent and resources to come to this particularly unfortunate state, and there is nothing wrong with it, none of the people have done anything bad, it is through no fault of our own that we find ourselves in this position, but they are the constraints within which I had to operate. This choice as compared to the other choices available to me seemed to me to be the only intelligent one to do.

Mr. BEVILL. This very thing is happening to a lot of these programs, and it certainly causes us a lot of concern here in this committee. We have the same thing in solar, $70 million invested in wind machines. You can just go right down the list. I don't know, it just seems like it is phony economics. I just don't know what the answer to it is, but your testimony is going to be helpful.

What will happen to the personnel that have been lined up? Does Livermore have the people already there in place to operate this?

Dr. TRIVELPIECE. Oh, yes. There are other activities at the laboratory, however, that are growing. Some of the strategic defense initiative activities will undoubtedly provide opportunities for some of these people. They simply won't work in the fusion program.

Mr. BEVILL. If more money is put into the fusion program, would this machine be one of the priorities, one of your priorities?

Dr. TRIVELPIECE. It is one of mine. I think we would back into it the same way we backed out.

Mr. BONER. Mr. Chairman, if the gentleman will yield?

Mr. BEVILL. Yes.

FUNDING REQUIRED TO OPERATE MFTF–B

Mr. BONER. What level of support would you say is needed to be required to operate that facility at some useful level?

Dr. TRIVELPIECE. Our estimates are around $35 million above the present level.

Mr. BONER. And what is the present level?

Dr. TRIVELPIECE. The $15 million that is in there is the amount that we regard as being essential to mothball it in such a way that it could be operated at some time in the future, but to go ahead with it, it would take an additional $35 million.

Mr. BONER. So then, Mr. Chairman, correct me if my math is wrong, you are saying it would take $35 million as the minimum that you could operate it?

Mr. BEVILL. Thirty-five more.

Mr. BONER. Thirty five more. The $15 million is going to be for mothballing. You sure wouldn't use that money.

Dr. TRIVELPIECE. No, there are certain contracts which we have entered into that can't be terminated easily, and the termination costs are equal to some of the mothballing costs. There are things in that $15 million that it is simply smarter to go ahead and have delivered than it is to abrogate the contracts and pay the termination costs.

Mr. BONER. When you say you need $35 million more, then if $15 million is to mothball it, then some of that $15 million could be applied to the $35 million couldn't it? Not everything in that $15 million is going—if it is going to mothball something, and there are some contracts there that you feel like you are going to have to go ahead and buy out anyhow——

Dr. TRIVELPIECE. I think I understand. To operate it, it is sort of a $50 million effect, so if we were going to operate, we would be asking for that amount. However, we are not, so we are asking for $15 million to mothball it, but if you don't mothball it and you op-

erate it, you still need a total of $50 million. That is why I said $35 million more.

Mr. BONER. But if you had $35 million total could you do it?

Dr. TRIVELPIECE. It would obviously operate at a reduced level. I don't know quite where—it is not exactly like slicing a sausage. I don't know where the cut point is on when it becomes ineffective to operate it at all, but there obviously would be one.

Mr. BONER. You don't know what that figure would be right now?

Dr. TRIVELPIECE. Not off the top of my head, no sir.

Mr. BONER. Mr. Chairman, it would appear to me that we are saying here, you have got $15 million, you are going to mothball it, and let's say you could operate at a total of $35 million, then you would put another $20 million in it and you have got a functional facility there that we spent some $400 million to build.

Can I ask one other question?

Mr. BEVILL. Sure, but before you do that, I think you have made a good point, but he is not saying a total of $35 million. He is saying $15 million, and that includes canceling the contracts and those expenditures that would occur to just mothball it that first year. Of course the second year it wouldn't cost that much.

Dr. TRIVELPIECE. That is correct.

Mr. BEVILL. Because you wouldn't have the mothballing?

Dr. TRIVELPIECE. Just maintenance.

Mr. BEVILL. You wouldn't have the contract problems that you have now, but you are really saying to operate it you need $50 million a year, if I understand you.

Dr. TRIVELPIECE. Yes sir.

Mr. BONER. Mr. Chairman, I agree with you, but I am just saying, let's say we reduce that. As he said, the total is $50 million. Let's say the total would $35 million.

Mr. BEVILL. I believe he answered that.

Mr. BONER. And if you could operate on $35 million, I don't know if that is the figure, but if you could, then you are only talking about putting another $15 to $20 million in to make it operational.

Dr. TRIVELPIECE. I don't know what the point of diminishing returns is.

Mr. BEVILL. That is slicing that sausage or whatever it was.

Mr. BONER. Do you use fusion to slice that sausage or what?

Mr. BEVILL. Did you have another question?

MOTHBALLING FACILITIES

Mr. BONER. I have to ask this question, Mr. Chairman. How did we get into this situation? No offense to you, Dr. Trivelpiece. We have got the President up here wanting $100 million for Nicaragua and we are going to get into a big fight over that, and we are doing a lot of things. How did we spend $250 million to build this thing and then just tell people when they asked us about how we are spending the taxpayers money that we are going to take another $15 million to mothball?

Dr. TRIVELPIECE. I tried to outline that a little bit. It was that the plans to do this were inaugurated during the period when the price of oil was high and the supply was low, and this seemed like a pru-

dent thing to do. The individuals that made the plan at that stage had no way of knowing—the individuals include both the representatives of the Executive and Legislative Branches who agreed to this program—that at the time it seemed like the prudent thing to do, and the construction project was completed during a period when we find ourselves with the Gramm-Rudman deficit reduction requirements incumbent on us. That legislation drove a great deal of activities that occurred in the debate between the Department and the office of Management and Budget, and we came to compromises in various areas.

This was one of the compromises that was worked out. In other words, then that meant I had to look at the overall balance of activities within the program, and we have taken cuts in the last two years of approximately ten percent each year, and that was possible to do some things in terms of stretching out construction contracts and so on to accommodate those reductions.

This year, however, that ability was no longer available to me, and instead of spreading some of these cuts in a more uniform way, it was necessary to look at some element of the program, and decide not to do it, so the Mirror activities throughout the fusion program have been terminated, That includes activities at MIT and Wisconsin and at the Lawrence Livermore Laboratory.

It was not possible to maintain what I felt to be the appropriate amount of activities in the program and adjust to this program level without doing something more drastic than simply spreading these around among various program elements.

Mr. BONER. Would it be possible to ask you to evaluate your program and submit to the committee a figure that you think could be a minimal that this facility could operate with?

Dr. TRIVELPIECE. Certainly.

[The information follows:]

MFTF-B

In order to operate the MFTF-B as originally planned, a year of further preparation is required to install auxiliary heating systems and diagnostics. This preparation would cost a total of $50 million in FY 1987. An amount of $15 million has been requested for "mothballing" MFTF-B in FY 1987, so additional funds of $35 million would be requried to prepare for operations, which would not begin until FY 1988. This would provide funds only for the MFTF-B facility itself, and an additional $10 million would be needed for theory and supporting mirror physics experiments such as the TARA at MIT. Actual operating costs for MFTF-B and supporting programs would be $70 million for FY 1988 and several years thereafter, which implies further increments in those years over FY 1987 funding levels needed to prepare MFTF-B for operations and to conduct theory and supporting experiments (i.e., $60 million)

We understand that Lawrence Livermore National Laboratory has been examining a more limited case where only one end of the device would be prepared for operation in FY 1988. We have not reviewed this option. However, an incremental $10 million for supporting experiments and theory would still be required in FY 1987, and a substantial increase in operating funds would be required in FY 1988.

Mr. BONER. Thank you, Mr. Chairman.

WIND PROGRAM—MOD-5

Mr. BEVILL. Miss Fitzpatrick, you mentioned the $70 million we have in the large windmill program known as the Mod-5B. Would

you furnish for the record also what is the minimum you could operate that program for?

Miss FITZPATRICK. Certainly, Mr. Chairman.

Mr. BEVILL. Of course, we are always concerned about the cost of termination. Do you know that offhand?

Miss FITZPATRICK. Not at the moment, Mr. Chairman. I will furnish that.

Mr. BEVILL. Will you put that in the record?

Miss FITZPATRICK. Yes, I will.

Mr. BEVILL. The termination and cost of operation?

Miss FITZPATRICK. Yes, sir.

[The information follows:]

MOD-5

The funding required to complete Mod-5 according to the original program plan of Hawaii and Boeing would be $16.2 million. This amount would enable installation, checkout and acceptance testing of the machine, at which point Hawaiian Electric Industries would purchase the wind turbine. Actual costs for completion may have to be re-estimated, however, since some project disruption has already occurred.

We estimate the project can be terminated for about $1.3 million in FY 1986. This will involve closing out the Boeing contract except for report preparation, restoring the site in Hawaii and NASA management support for the project. The government will lose the $4 million from the sale of the completed machine but this should be partially offset by anticipated revenues from sale of the uncompleted machine and scrapped tower.

INVESTIGATIVE REPORT ON MAJOR FACILITIES PROGRAM

Mr. BEVILL. That will be very helpful to the committee.

This investigative report here, made by our committee investigative staff, has shown where we have just invested in these energy projects, and then stopped them, and we have wasted billions of dollars. It appears that is going to be the outcome. Would you recommend—I will just ask all three of you to comment on this—what do you recommend the Congress do on these things? We put up this money, we build them, then we stop them. I would like to get the benefit, and I am sure the committee would, of your opinion as to what we as a committee and as a Congress may do about these programs.

We realize, as Dr. Trivelpiece pointed out, that circumstances change. Six years ago, seven or eight years ago, we were hollering there was going to be an energy shortage, which I guess there still will be, and this may be a disaster in disguise, with the mood changing because of the oil glut, which may be tertiary, I don't know. We can't seem to get accurate information as to what our circumstances are.

We have over-built in nuclear power plants because the information was that we were going to run out of oil in the world around the year 2000, and here we are with a glut of oil, and that is just completely the opposite of the information that we received.

I would like to get some advice from the three of you as to what we might do. I will be glad to hear any off the cuff remarks any of you would like to make now, but I would ask you to go into detail for the record as to what you recommend that we do for these energy programs.

We even changed the name of this subcommittee to Energy and Water because energy was so important.

We feel like in the long run we are making a big mistake in stopping these energy programs and wasting all this money. We would like your advice on that. We will put this investigative report in the record for your reference. If there is no objection we will just make it a part of the record.

[The investigative report follows:]

NOT FOR RELEASE UNTIL AUTHORIZED BY THE COMMITTEE

A REPORT TO

THE COMMITTEE ON APPROPRIATIONS

U.S. HOUSE OF REPRESENTATIVES

on the

DEPARTMENT OF ENERGY'S MAJOR FACILITIES PROGRAM

Surveys and Investigations Staff

February 1986

NOT FOR RELEASE UNTIL AUTHORIZED BY THE COMMITTEE

February 3, 1986

MEMORANDUM FOR THE CHAIRMAN

Re: Department of Energy's
Major Facilities Program

By directive dated July 9, 1985, the Committee requested a study of the management, processes, and procedures of the Department of Energy's Major Facilities Program to identify the causes for the termination or deferral of several specific projects.

The study has been completed and the results are included in the accompanying report.

Respectfully submitted,

R. W. Vandergrift, Jr.
Acting Chief of the Surveys and
Investigations Staff
House Committee on Appropriations

Douglas D. Nosik
Assistant Director
Surveys and Investigations Staff
House Committee on Appropriations

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LIST OF ACRONYMS

PROJECTS

AGC	-	Advanced Gas Centrifuge
AVLIS	-	Atomic Vapor Laser Isotope Separation
CRBR	-	Clinch River Breeder Reactor
EBT-P	-	Elmo Bumpy Torus - Proof of Principle
FFTF	-	Fast Flux Test Facility
FMEF	-	Fuels and Materials Examination Facility
FMIT	-	Fusion Materials Irradiation Test Facility
GCEP	-	Gas Centrifuge Enrichment Plant
ISABELLE	-	Intersecting Storage Accelerator
MFTF-B	-	Mirror Fusion Test Facility
SIS	-	Special Isotope Separation
SSC	-	Superconducting Super Collider

LABORATORIES/RESEARCH CENTERS

BNL	-	Brookhaven National Laboratory
CERN	-	European Center for Nuclear Research
HEDL	-	Hanford Engineering Development Laboratory
LLNL	-	Lawrence Livermore National Laboratory
ORNL	-	Oak Ridge National Laboratory
SLAC	-	Stanford Linear Accelerator Center

ORGANIZATIONS

AEC	-	Atomic Energy Commission
DOD	-	Department of Defense
DOE	-	Department of Energy
ERDA	-	Energy Research and Development Administration
GAO	-	General Accounting Office
IG	-	Office of Inspector General
OFE	-	Office of Fusion Energy
OMB	-	Office of Management and Budget
OSTP	-	Office of Science and Technology Planning

MISCELLANEOUS

ERAB	-	Energy Research Advisory Board
ESAAB	-	Energy System Acquisition Advisory Board
MSA	-	Major Systems Acquisition
R&D	-	Research and Development
PEB	-	Process Evaluation Board
SWU	-	Separative Work Unit

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SUMMARY

The Department of Energy (DOE) is heir to the legacies of the Energy Research and Development Administration (ERDA) and the Atomic Energy Commission (AEC). Whereas the AEC was responsible for the development of a nuclear program, DOE's mission includes nuclear, solar, fossil, and fusion programs. DOE also constructs major facilities for the high energy physics and nuclear physics communities, and develops research and production programs to support Department of Defense objectives. As of June 1985, DOE had 446 projects with total estimated costs of $39 billion. In FY 1985, DOE spent about $2.9 billion of its appropriation on its projects. Furthermore, FY 1985 program funding was $1.65 billion for uranium enrichment, $388 million for breeder and related technologies, $437 million for magnetic fusion, and $545.6 million for high energy physics.

DOE Management Problems

Management of DOE can be characterized as lacking continuity. During its first 8 years, it has had five Secretaries, five Deputy Secretaries, as well as an extensive turnover in Assistant Secretaries. This lack of continuity in upper level management has been blamed, in part, for the agency's perpetuation of projects inherited from AEC or ERDA programs.

DOE has also experienced a high turnover of technically skilled managerial personnel. During the transition from the AEC to DOE, the character of program management has moved from technical people who were asked to manage, to short-termed managers who are required to make project funding decisions involving technical data analysis.

DOE officials acknowledged that a major criticism of agency management relates to its candor when dealing with the Congress. Senior management has been accused of being reluctant to discuss problems with Congress for fear it will result in reduced program funding. In this respect, senior management believes they often receive misinformation about the efficiency of projects from program constituents. Laboratories and programs barrage the system with new project data and ideas. Therefore, DOE management must distinguish the project ideas with merit from those which are based on faulty data or flawed technical assumptions. Unfortunately, DOE's assessment system does not extrapolate the information well to the Congressional level. There is wide agreement that DOE often does not have or disclose adequate information for Congress to fully understand its options.

Inconsistent Patterns of Project Classification and Funding

Only 25 DOE civilian projects have estimated individual costs in excess of $50 million. Fifteen of these projects are classified as Major Systems Acquisitions (MSA's) with total project cost in excess of $200 million. In recent years several MSA projects have become embarrassments to the agency. MSA projects have been completed but not used, deferred, terminated, or mothballed.

DOE provided a list of "terminated" projects which included the Fuels and Materials Examination Facility (FMEF), a project built to examine reactor fuel assemblies, which is still being completed and omitted the Mirror Fusion Test Facility (MFTF-B), a fusion energy experiment, whose project status could best be classified as "in limbo." Determination of a project's actual status is often hampered by the absence of any clearly defined completion criteria capable of verification. Projects which have been described as complete or "essentially complete" may require additional appropriations of several hundred million dollars if they are to meet production/operational goals.

A budget examiner indicated DOE spent $600 million to complete a project reported to cost $314 million. The source of those additional funds could not be explained. By one definition, DOE projects are complete when plant and capital equipment funds are exhausted. This definition can be questioned because DOE management views funding designations as artificial barriers which need not be observed and have often been ignored in order to finish project development. DOE program officials admitted operational funds have been used for construction and other purposes. In most cases these funds are used to debug, tune-up, or retrofit projects so they can be completed to meet original design or scientific specifications. There was one example, provided by a DOE official, where $100 million of operating funds were spent on a project which was never authorized.

DOE management indicated funding problems have been caused by the difficulty of accurately predicting the cost or performance for first-of-a-kind research tools and processes which surpass state-of-the-art technology. However, the DOE Office of Inspector General is expected to report in February 1986 that agency management of MSA's does not comply with OMB guidance and that many projects lack required documentation, including project plans. These deficiencies were first reported by GAO in 1979 and again in 1981.

Generic Issues Concerning Terminated or Deferred Projects

There is no common cause for DOE's termination or deferral of their MSA projects. Justifications for the breeder, fusion, and plutonium production projects were postulated on near-term exigencies. The energy crisis projected that breeders would be

needed by 1980, and commercial fusion reactors by the year 2000. The fusion program was accelerated even though an assessment of the state of the technology would have characterized it as very high risk.

Program officials indicated the justifications for the Gas Centrifuge Enrichment Plant (GCEP), a uranium enrichment facility, and Isabelle, a high energy physics project, were not as valid as for other projects. The need, the readiness of the technology, and the ease with which known technology could be extrapolated to higher orders of magnitude were overstated.

On GCEP; the Clinch River Breeder Reactor (CRBR), a demonstration breeder project; and another terminated fusion project, Elmo Bumpy Torus (EBT-P), one of the underlying goals of program management was to establish an industrial base for the programs to insure industrial support for future generations of facilities. Only the EBT-P effort was considered a success as it allowed industry to establish its own joint ventures as prime contractor candidates. For GCEP and CRBR, DOE involved a variety of contractors hoping that the process would breed some healthy competition. Instead, the processes created confused management structures which resulted in delays in meeting project milestones.

Another characteristic common among some projects was the failure to follow the originally-planned sequence of project construction. CRBR was scheduled to be designed and built after, not in parallel with another breeder project. MFTF-B was to be constructed after its design was verified by a smaller mirror project, but management did not wait for verification. Only on the EBT-P fusion project did the project management wait for data verification before starting construction. That decision was rewarded when the data indicated the facility, as designed, would not work.

Many DOE projects developed their own momentum, i.e., the technologies drove the projects. Design, construction, and systems R&D moved in parallel courses. DOE officials, in retrospect, admit these were reckless courses. A senior DOE official stated that once a project gets approved, it is often difficult to get it terminated. DOE project managers have often been described as project advocates and as a result lose their management perspective. They chart cost and schedule, but the technical issues upon which the success of some projects depend, especially the high energy physics or fusion projects, are unchallenged.

The problem, as stated by a DOE official, is that DOE lacks an information "feedback loop" from program to project as these facilities move through a series of new rationales and justifications. While DOE heralds projects such as GCEP and CRBR as models of good management, contemporaneous events, such as the relaxation of the energy crisis, were not factored into the decisions to continue these projects. For example, DOE's project management system ignored feedback on GCEP regarding projected

demand for enriched uranium and on CRBR regarding the price and availability of uranium. The energy crisis was past, yet these projects survived on what appears to have been artificially-created assumptions of need.

The last generic project issue concerns how well the lessons of the past will be heeded by present and future projects. The lessons of Building 371--Rocky Flats, a plutonium production facility, seem lost on current DOE projects, particularly the Lawrence Livermore National Laboratory Special Isotope Separation project. Program management indicated there were many lessons learned from Building 371, not the least important was the need to prototype and build pilot systems to assure successful systems integration. Lawrence Livermore Laboratory has done lab scale verification, but apparently wants to forego prototype verification.

Building 371--Rocky Flats

Building 371 is different from most other projects reviewed in this report because the Department of Defense (DOD) is clearly the identified "user" for its product. There is none of the ambiquity attached to fission or fusion projects, such as trying to explain the commercial relevance or user orientation of a project. Building 371 was not intended to extend the parameters of science, nor was there R&D language in the project proposal. During the course of project development, however, these issues were commonplace.

Project management admitted that DOE contributed to the failure of Building 371 by needlessly fast tracking the project. Also, DOE's contractor certified the system acceptable before DOE learned it operated at only 7-8 percent of design capacity.

Rocky Flats was described as a "plumber's nightmare." Contractors with no plutonium handling experience and DOE health and safety personnel were designing systems in parallel to construction. Safety goals, not production, became the higher priorities. Design became incompatible with output. Eventually the building was complete, but the designs for internal systems were not. Procurements were made too far in advance and equipment was left rusting in the field because it could not be installed.

DOE officials admit that if adequate testing had been conducted at Rocky Flats it should have determined that the design had overlooked maintenance requirements, and that the components would not work together as a system.

DOE is now reviewing a retrofit cost estimate submitted by the contractor which tested Rocky Flats' systems. One such cost estimate provided by DOE officials at Albuquerque was over $500 million. Officials cautioned to say that, although DOD still needs a production facility, none of the retrofit proposals will bring the facility up to design capacity.

Uranium Enrichment--The Gas Centrifuge Enrichment Plant and the Atomic Vapor Laser Isotope Separation Process

Management of the uranium enrichment program illustrates two problems in DOE program management. First, the influence of political considerations on DOE project decisions, and second, the problems that occur when project management ignores demand and economic conditions which make project continuation a mistake.

In 1974, the United States controlled 100 percent of the world market in enriched uranium. With burgeoning domestic and foreign nuclear programs, two critical decisions were made. The AEC closed the U.S order books and, in 1975, obtained approval for a new enrichment facility. Foreign markets, recognizing the unreliability of U.S. supply, constructed their own facilities for the production of separative work units (SWU's) of enriched uranium. An SWU is the measure for production and sale of enriched uranium. Europe deployed cheaper machines which have produced SWU's successfully for years, while the U.S. program followed a high cost course which priced itself out of the market. Current DOE management said program technocrats forgot DOE's uranium enrichment program was supposed to be a business, a source of revenue, and a credit in the balance of trade marketplace.

Former DOE officials indicated the decision to build an 8.8 million SWU gas centrifuge plant was not justified from its inception. The justification was transparent. Efforts to have the administration recognize these facts were rebuffed. Subsequent GAO warnings about the cost effectiveness were also ignored. Through its life, the justifications and rationales which kept GCEP alive shifted constantly. Eventually, a decision was made to develop an advanced gas centrifuge (AGC) machine which was to have an SWU capacity three times greater than GCEP's original centrifuge machines.

A former DOE official stated that while project management tracked cost and schedule, the program lacked cost discipline. As with other projects, technology and industrial constituencies provided momentum for the project. Project proponents drafted outdated projections of demand to justify continuation while ignoring the trend of U.S. nuclear plant cancellations.

By 1984, the image of GCEP as a "public works" project which cost the taxpayer nothing, had dissolved. DOE recognized a billion-dollar-a-year appropriation would be required to support GCEP and the uranium enrichment program.

To shore up its program, the Secretary requested a Process Evaluation Board assess AGC and a competing uranium enrichment technology--the Atomic Vapor Laser Isotope Separation (AVLIS) process. The Board was asked to provide a technical-based business decision for deploying one of the technologies, and provide the Secretary with evidence to take to the Congress for continuing or terminating GCEP/AGC.

The Board functioned like a court of law with advocacy groups from AVLIS and AGC defending their respective projects while prosecuting their competitor. The Board identified systemic problems in the uranium enrichment program created by the AGC/GCEP project infrastructure. Prior to the Board's review, there had been no auditing of the facts presented by the labs about AGC. What emerged from the process were allegations that AGC project data was inaccurate and outdated, and that project management had lost its objectivity and had restrained efforts by technical and economic reviewers to present accurate data. The AGC was not a simple extrapolation of engineering technology as claimed.

To summarize the net effect of Board recommendations; AGC and GCEP were cancelled, AVLIS was given an opportunity to prove its cost-effectiveness, and the gaseous diffusion plants demonstrated they were still the facilities to beat. A recent upgrade of the gaseous diffusion plants, a $1.5 billion investment, has apparently paid off.

The timetable for AVLIS to demonstrate cost effectiveness is still in draft form. The best estimate is that within the next 4 years at a cost of $388 million, AVLIS will have an opportunity to prove its technology. Program management has stated its intent to carefully monitor this project; it does not want AVLIS to go the way of GCEP. Deployment of AVLIS will be guided by demand and economic factors. If market trends continue, AVLIS may become a proven technology, but not cost effective in the present economy.

Fission--The Clinch River Breeder Reactor and Fuels and Materials Examination Facility

During the energy crisis of the early 1970's, development of nuclear power was on the assent and the need for advanced reactors was thought to be imminent. Uranium shortages and price escalation led to the proposal of CRBR. Under a very autocratic management scheme implemented by the AEC, the desire to develop an industrial base for the breeder reactor program became a high priority. However, in 1977, CRBR became a "political football." Over administration objections, Congress continued to fund the project. For several years the project marked time as hundreds of millions of dollars were spent buying, testing and retesting components and systems.

In 1983, Congress withdrew its support for CRBR recognizing that the price of uranium was closer to $20/lb., not the $150/lb. at which a breeder becomes cost competitive; and that projected use of nuclear power made the project obsolete. Senior management believes that CRBR's termination has caused the nuclear program to fall into disarray. As an example of this program's problems, officials suggested funds have been indiscriminately provided to the labs.

Administration views of the late 1970's on nonproliferation were seen by DOE as an opportunity to propose and build the Fuels and Materials Examination Facility (FMEF). However, the purpose for FMEF and its implied effect on the continued operation of other facilities was never clarified. By the time the facility was almost complete, DOE still had not decided on which equipment to install in it. In 1984, an internal document indicated DOE was concerned FMEF would become an embarrassment to the agency. Today there is still $20 million worth of unused equipment stored near the project site.

According to DOE officials, a 1985 Congressional conferee report was a clear signal for DOE to clean up its nuclear program. In the past, trying to interpret the signals sent to DOE by Congressional committees has led to some programmatic confusion. When CRBR was cancelled, various nuclear project offices applied their own interpretations to this Congressional action. Some staffers viewed the maintenance of substantial program funding as Congressional permission to "leap-frog" CRBR and work toward a prototype.

Taking direction from the conferee report, DOE has drafted a Strategic Plan for the nuclear program. The plan is not intended as a panacea for the U.S. nuclear option, but rather as a rational approach to future nuclear projects. After this plan is reviewed by the Energy Research Advisory Board and subjected to marketplace analysis, DOE may employ a Process Evaluation Board-type process to select a single reactor system for development. Cynics doubt the plan will be successful because it forbodes a significant scale back of funds to laboratories. Optimists, however, believe that letting the marketplace, not the laboratories, dictate the program, is long overdue.

The Fusion Program--The Mirror Fusion Test Facility Project

The fusion program has generally been described as "too much, too fast." The program was accelerated toward reactor development. The impetus for program speed was dictated in part by the Magnetic Fusion Energy Engineering Act of 1980. However, since 1980, two factors have changed the pace of the program. First, the sense of urgency for fusion reactors has gone, and second, significant problems have materialized in fusion's technological development.

MFTF-B was authorized solely as a competitive concept for another fusion concept. MFTF-B was authorized at a time when its experimental viability was supported by a paucity of data. Since 1984, or earlier, data from a smaller fusion experiment suggests MFTF-B has serious design problems. The Office of Fusion Energy (OFE) is not ready to pre-judge Lawrence Livermore National Laboratory's (LLNL) ability to correct these problems, but has scheduled a project review for MFTF-B in April 1986. It is hoped

that data from additional experiments will clarify the project options. Although Lawrence Livermore will lobby hard for project continuance, the Office of Fusion Energy must determine the project's readiness for experimentation. If it is not ready, MFTF-B may require a substantial appropriation to correct design problems.

Congressional options for MFTF-B and the fusion program should be understood in the context of the Magnetic Fusion Program Plan. The plan indicates that until the viability of fusion is demonstrated, engineering and facilitization must wait; it is indicative of the need for a stronger basic research program. This portends a longer period toward commercialization, and DOE officials believe that unless international cooperation is arranged, Congress could be asked to support this program at a rate of $400 million per year, and more, for the next 70-80 years.

High Energy Physics Projects--Isabelle and the Superconducting Super Collider (SSC) Project

Accelerators, also known as atom smashers, are the research tools for high energy physics. According to a High Energy Physics Advisory Panel member and others, the major benefit of high energy physics projects is the achievement of scientific discoveries used to win Nobel Prizes in physics. These projects have no energy-related objectives. Their goal is to better understand the nature and composition of subnucleonic particles.

Among several accelerator projects developed by DOE, the most noteworthy has been Isabelle. When authorized, Isabelle was expected to discover two previously unobserved, but postulated particles. However, the Brookhaven National Laboratory experienced magnet development problems, and the European Center for Nuclear Research (CERN) won the race to discover the "w" and "z" particles.

A senior DOE official stated that another problem with Isabelle was that it was pushed ahead of the readiness of the technology. The high energy physics group did the pushing, but when CERN made the particle discoveries, Isabelle was no longer the premier accelerator facility the high energy physics community had envisioned. High energy physics withdrew its support for Isabelle and backed development of the $8 billion Superconducting Super Collider (SSC) facility.

The fate of Isabelle accentuates two programmatic characteristics of the U.S. accelerator program; first, the program requires high-risk, high-cost projects, and second, it acknowledges the competition with European and other facilities for scientific discoveries. This competition provides the reason the Stanford Linear Collider is being built and funded. The Stanford project was designed to be ready for experiments before a newer and more

costly European accelerator is completed. With a 2 year experimental advantage, the Stanford project can gain back some of the prestige lost when Isabelle failed to win the race for particle discoveries.

It is this competitive philosophy between world research programs which doomed Isabelle and now clouds support for the SSC project. While the U.S. high energy physics community has claimed SSC is a scientific imperative to nurture tomorrow's physicists, there is mounting opposition to the project because of its great expense, the funding impact it would have on other research programs, and the reality that the Europeans might adapt their facilities to win the race for discoveries expected to be made by SSC.

I. INTRODUCTION

A. Directive

By letter dated July 9, 1985, the Committee on Appropriations directed the Investigative Staff to conduct a review of the Department of Energy's (DOE) Major Facilities Program. The focus of the effort was to review program management structure, processes, and procedures and to identify the factors which caused facilities to be cancelled, delayed, and/or fail to operate.

The Committee on Appropriations identified seven projects which were illustrative of these problems. The list included:

Gas Centrifuge Enrichment Plant
Clinch River Breeder Reactor
Mirror Fusion Test Facility-B
Isabelle
Fusion Materials Irradiation Test Facility
Fuels and Materials Examination Facility
Building 371--Rocky Flats

B. Scope of Investigation

During this review DOE officials (past and present) were interviewed, including the program and project staff responsible for the facilities highlighted in this report. Also contacted were representatives from industry groups, such as the Edison Electric Institute; DOE advisory groups, such as the Energy Research Advisory Board, the Magnetic Fusion Advisory Committee, and the High Energy Physics Advisory Panel; academia, including faculty from Massachusetts Institute of Technology and California Institute of Technology; ad hoc groups, such as the Tri-Committee Business Advisory Panel; other Government agencies including the Nuclear Regulatory Commission; and various private sector enterprises including architectural engineers, reactor component and centrifuge manufacturers, utilities, Government contractors, and consultants.

Field trips were made to six national laboratories: Brookhaven National Laboratory, Long Island, New York; Hanford Engineering Development Laboratory, Richland, Washington; Lawrence Livermore National Laboratory, Livermore, California; Oak Ridge National Laboratory, Oak Ridge, Tennessee; and Sandia and Los Alamos National Laboratories, New Mexico.

Project files, including project plans, progress reports, etc., were reviewed as were project management documents such as DOE's Project Management System Handbook. Numerous other internal and external documents were reviewed including various U.S. General Accounting Office and Office of Inspector General reports, DOE's magnetic fusion plan, a strategy paper for the uranium enrichment enterprise, a draft nuclear program plan, and numerous other documents pertinent to the review.

C. Background

1. Agency History

During the past 10 years the U.S energy program has had to react to significant energy-related events. These include the 1973/74 Arab oil embargo, the Three Mile Island accident, and a difference of opinion regarding the viability of the nuclear power option. Also, the history of responsibility for U.S.-funded energy efforts has been one of change. The initial U.S. Government agency to address energy-related issues was the Atomic Energy Commission (AEC). In 1974 Congress separated the nuclear advocacy function from the regulatory function, thereby abolishing AEC and establishing the Nuclear Regulatory Commission and the Energy Research and Development Administration (ERDA). After about 3 years ERDA was abolished and, in October 1977, DOE was established with the role of identifying and developing solutions to U.S. energy needs. In more recent years the agency mandate has changed to the more risky, long-term research and development (R&D) in areas not likely to be pursued by industry.

2. Agency Mission

DOE's primary mission is to explore means of energy efficiency from sources other than oil. It also helps fund energy technologies such as solar and fusion, while also providing and operating the large-scale facilities required for basic research in the physical and life sciences. In addition, DOE supports the national security objectives by providing and maintaining a nuclear weapons complex of sufficient capacity and capability to assure a prudent level of flexibility in national security options.

A DOE project is generally a unique effort within a program with prescribed cost, schedule, and performance parameters. Although various criteria exist for categorizing the projects, they may generally be divided into three categories according to level of funding. Projects estimated to have a lifetime cost in excess of $200 million are considered major systems acquisitions (MSA's); those with an estimated lifetime cost of $50 million to $200 million are categorized as major projects; and those under $50 million fall into an "other" projects category.

In June 1985, DOE had 446 projects; 23 MSA's, 25 major projects, and 398 others. Project cost is defined in two ways--total estimated cost which is the cost of construction including cost of design, engineering, and the equipment necessary to put the facility in operation, and total project cost which is the total estimated cost and all other costs, such as operating costs, which are identifiable to the project over its lifetime. In June 1985, total estimated cost of the 446 projects was about $39 billion. In FY 1985 DOE spent about $2.9 billion of its appropriation on its projects, and in FY 1986 it requested about $2.5 billion.

II. MAJOR FACILITY MANAGEMENT

A. Programs

Project management operates under two levels of authority: (1) field office/project site control, and (2) headquarters control. The latter includes both the Washington, DC, and Germantown, Maryland, program and policy levels of decision-making. Headquarters is responsible for evaluating project proposals in terms of their support of program goals and overall compatability with agency objectives. Following is a description of the five DOE programs responsible for the projects reviewed in this report.

1. The Defense Program at Rocky Flats

The primary responsibility of Defense Programs is the design, testing, and manufacturing of nuclear warheads. It is a unique DOE program in that it has an identified customer, the Department of Defense, and national security plays an important role in its operations. The Plutonium Recovery and Waste Treatment Facility, better known as Building 371, was to be a showcase plutonium processing installation at DOE's Rocky Flats plant near Golden, Colorado. Rocky Flats is an integral part of DOE's Defense Programs.

Building 371 was designed to replace 1950's vintage plutonium processing equipment with more modern materiel, providing enhanced protection to workers and the environment. Another driving force for Building 371 was that the old facilities could not meet the then perceived DOD demands for new warheads.

2. The Uranium Enrichment Program

Uranium enrichment is a process which prepares uranium for use as a nuclear reactor fuel. The Nuclear Non-Proliferation Act of 1978 committed the United States to a policy of having available the enrichment capacity to meet foreign demand on a long-term basis. By law, DOE must recover program costs in a reasonable period of time. By administrative requirement, its annual cost cannot exceed revenues, i.e., an annual net zero appropriation balance.

DOE's existing uranium enrichment capacity consists of two gaseous diffusion plants located at Portsmouth, Ohio, and Paducah, Kentucky. Until 1985, DOE operated a third plant at Oak Ridge, Tennessee, but recently placed this plant in a standby status. These plants were constructed in the 1940's and 1950's to satisfy military requirements for highly enriched uranium. Since the 1960's, however, the plants have primarily been used to provide enriched uranium for domestic and foreign nuclear power plants. A $1.5 billion program to improve the efficiency and capacity of the three plants was completed in 1983 and the new capacity is

about 27 million separative work units (SWU's). An SWU is the amount of effort expended to separate a given amount of natural uranium into two components--a high and a low concentration of fissionable uranium-235. An SWU is the measure for production and sale of enriched uranium. The recently cancelled Gas Centrifuge Enrichment Plant (GCEP) at Portsmouth, Ohio, was intended to increase the available production capacity of U.S. SWU's by 8.8 million units.

3. The Breeder and Advanced Reactor Programs

The objective of the program is to advance nuclear technology by conducting concept related R&D to enhance operation, reduce cost, improve safety, and foster public acceptance of current and future generation nuclear reactors. DOE officials indicated that what is implicit, but not stated in the program objective, is the ability to demonstrate the commercial application and user orientation of the R&D.

Over $380 million was appropriated for civilian (non-defense) nuclear research programs during FY 1985. This is part of the Nation's continuing energy strategy aimed at energy independence, resource conservation, and establishment of a long-term inexhaustible energy resource whose technology and economic potential are assured.

From 1970 until its termination in 1983, the Clinch River Breeder Reactor (CRBR) was the flagship of DOE's nuclear program. CRBR was intended to demonstrate that a commercial scale breeder reactor could be operated reliably and safely on a utility electric supply system. A project which program management proposed to support CRBR and other breeder projects was the Fuels and Materials Examination Facility (FMEF). FMEF was intended to develop fuel cycle information based on the examination of fuel materials and absorber assemblies which had already been irradiated.

4. The Fusion Program--Magnetic Confinement Systems

DOE seeks to develop the science and technology of magnetic fusion energy and to determine its engineering feasibility. Headquarter's responsibility for this program rests within the Office of Fusion Energy under the Director of Energy Research. Laboratory R&D programs are conducted at several national laboratory, university, and private sector facilities. The fusion program is aimed at harnessing thermonuclear reactions to provide an inexhaustible supply of electrical energy.

The purpose of the fusion program is to evaluate the viability of the various fusion concepts. There are two major experimental efforts for this purpose. One is based on closed geometry, namely tokamaks, and the other on open geometry, namely mirrors.

During the years prior to 1980, DOE concentrated its R&D efforts on the tokamak concept. The flagship of the fusion program was Princeton University's $314 million Tokamak Fusion Test Reactor. In 1980, Congress passed the Magnetic Fusion Energy Engineering Act. According to DOE officials this legislation signaled to DOE that the "fusion program represented the will of Congress." In 1983 GAO reported that Congress wanted an accelerated development program leading to the demonstration of the commercial viability of fusion. The act envisioned the Government's construction of a commercial-sized reactor demonstrating the economic viability of fusion energy by the end of the century. The act also required DOE to pursue a number of fusion energy concepts so that the advantages and disadvantages of each could be assessed and an optimal design clearly identified.

With reactor development as the then-stated goal of the fusion program, DOE "fast tracked" the development of alternative fusion concepts including the Mirror Fusion Test Facility-B (MFTF-B). It also authorized construction of the Fusion Materials Irradiation Test (FMIT) facility to support the materials development program.

5. The High Energy Physics Program

High energy physics is a field where the various world centers for physics compete for new discoveries. The most intense rivalry is usually between the United States and the European Center for Nuclear Research (CERN) in Geneva, Switzerland.

There are three main centers of high energy research in the United States:

-- Fermi National Accelerator Laboratory (Fermilab), Illinois, where the Tevatron accelerators are located;

-- Stanford Linear Accelerator Center (SLAC), California, where the Stanford Linear Accelerator is under construction, and

-- Brookhaven National Laboratory (BNL), New York, where the Intersecting Storage Accelerator (Isabelle) was under development.

High energy physics is an exploratory field of basic science that attempts to determine the most fundamental composition of energy and matter; how these components interact with one another; and the interrelationships of the elemental forces and their effect on matter. As such, high energy physics has no basic energy related objective; it is primarily a National Science Foundation supported program with DOE managing the construction of the needed facilities.

Most experiments in high energy physics depend on specialized machines called accelerators or atom smashers. Accelerators are extremely complex machines that enable the physicist to see inside the atom and its nucleus. These machines produce and accelerate beams of particles (e.g., protons, electrons, etc.) to nearly the speed of light. The particles are then collided with fixed targets or other accelerated beams to break them into smaller constituent particles.

B. Role of National Laboratories

The national laboratories are commonly Government-owned facilities which are operated by contractors. These contractors include individual universities, university consortia, and industrial firms. Laboratories act as technical agents for DOE and are given lead missions involving broad technical management responsibilities for planning and performing research and development work for DOE. Between 10 and 20 percent of each laboratory's work is done for agencies other than DOE. DOE is required to make its labs available to the Nuclear Regulatory Commission. Labs do both basic and applied research and development.

For purposes of contract administration, DOE field operations offices oversee the labs. For purposes of programmatic and institutional management, the labs report to the Director of Energy Research or to the program Assistant Secretary who funds the major share of the labs' work. The general type and level of activity to be conducted at each lab is based on an agreement between the labs and the Director of Energy Research or program Assistant Secretaries sponsoring work, and the responsible operations office. The agreement results in guidance to the labs for long-range planning and budget preparation and for site development plans. It also serves as the baseline for placement of work at the lab.

C. Role of Advisory Groups

Thirteen advisory groups serve the Department of Energy. They include the Energy Research Advisory Board, High Energy Physics Advisory Panel, Magnetic Fusion Advisory Committee, and the Nuclear Science Advisory Committee. Members of these groups are appointed by the Secretary of Energy and tasked by the Secretary or Director of Energy Research to review specific projects or advise on management and policy matters. The areas of study are identified to the groups and their reports are advisory only; the Department is under no obligation to follow the groups' advice. Opinions differ regarding the influence exerted by these groups. One advisory group member questioned whether the groups have any influence on DOE while others note DOE's acceptance of their recommendation to terminate a project as an example of the advisory groups' influence. Four of the panels encountered during this study are described below:

-- Energy Research Advisory Board - Prior to DOE, the General Advisory Committee advised the AEC regarding nuclear weapons and energy. The committee was transferred to ERDA when AEC was abolished but was not subsequently transferred to DOE. Following in this tradition, however, the Energy Research Advisory Board was established by DOE. This board is comprised of about 25 members from the private sector. The membership, appointed by the Secretary, is to reflect a balance of technical expertise and viewpoints in energy R&D. It provides expert guidance to high level DOE management on a wide range of energy matters as requested by the Secretary.

-- High Energy Physics Advisory Panel - The 15 members of this panel provide advice to DOE management on the national high energy physics research program. Advice is given on long-range plans, priorities, and strategies; the level of funding necessary to assure a world leadership position; and the maintenance of a balance between competing elements of the program.

-- Magnetic Fusion Advisory Committee - The 16 members of this Committee provide advice on long-range plans, strategies, and priorities to demonstrate the scientific and engineering feasibility of magnetic confinement fusion systems. The committee also advises on the level of funding to develop program strategies and to maintain a balance between competing elements of the program.

-- Nuclear Science Advisory Committee - This committee provides advice to DOE and the National Science Foundation on scientific priorities within the field of basic nuclear science research. This field includes experimental and theoretical investigations of atomic nuclei. Committee activities include recommendations concerning adequacy of present facilities and the need and relative priority for new facilities.

III. PROBLEMS IN MANAGEMENT OF DOE MAJOR FACILITIES

A. DOE Staffing Difficulties

1. Lack of Continuity in Management

Continuity in the upper level management structure has been a major problem at DOE. In the past 8 years, DOE has had five Secretaries, five Deputy Secretaries, nine Under Secretaries, many other vacant high level positions, and "acting" managers in appointed positions. This can specifically be demonstrated in that the position of Assistant Secretary for Nuclear Energy has been vacant since September 1984.

DOE officials and others note that it is difficult, or nearly impossible, to obtain experienced leadership for these high level positions. Conflict of interest laws are cited as the primary stumbling block and comparatively lower salaries may also contribute. According to some, lower salaries and conflict of interest laws may require candidates for these positions to exhaust personal resources while serving the agency, and may also prevent incumbents from returning to the industry positions they know best. One result, it is claimed, is the positions attract those who wish to obtain experience rather than provide it.

Perhaps partially due to the absence of continuity in the top positions, agency management has been widely criticized as lacking the technical background and experience necessary for informed decisionmaking on complex projects and programs. Program managers have not escaped the criticism; some were characterized as "bureaucratic cheerleaders," lacking in leadership, and lacking the capability to adequately monitor work performed by the labs. This situation has been contrasted to the AEC management which has been described as technically competent and comparatively stable.

This lack of stable and competent agency management may have resulted in the lobbying efforts by the labs, contractors, and local interest groups being effective in preserving projects and programs beyond their useful life. This has also led to suggestions that mechanisms be added to provide stability and leadership to DOE. These suggestions include a guiding body similar to the AEC's General Advisory Committee, Presidential commissions for specific programs, and a joint Congressional commmittee to transcend administration and Congressional terms.

There is some indication that current agency management recognizes mistakes of the past and desires to take corrective action. This is evidenced by action taken to terminate some inherited projects, e.g., the Gas Centrifuge Enrichment Project. Management has also stated its intent to review all programs with the objective of prioritizing projects and eliminating those which do not further the goals and objectives of the U.S. energy program.

Current management is aware of the realities surrounding the siting of new projects or termination of existing ones. It hopes to transcend parochial interest by establishing an informed decisionmaking process, involving high level agency management in appropriate decisions, and documenting the decisions so they can be logically articulated.

2. The Impact of Changing Administrations

The political appointment system has exacerbated the turnover problem in DOE management. Several officials stated that an administration's influence can be harmful to program continuity. From the perspective of one former DOE official, dealing with a new administration every 4 years has always been a struggle. As a cabinet-level agency, DOE's programs are expected to mirror administration policies. One administration may support a project while another does not. The technical base within DOE may support a project, but the agency's administration-appointees may not.

For many of the "nonpoliticized" DOE program managers, the conflict with the administration stems from confusion created by the authority of the Office of Science and Technology Planning (OSTP) over DOE's mission. DOE views its mission as formulating and implementing energy programs and policies, not implementing programs and policies formulated by OSTP. DOE's view of their mission was strongly supported by a number of energy consultants who indicated energy programs (i.e., fusion, fossil, nuclear), have life cycles which must exceed 4-8 year administration lifetimes.

B. Project Development Problems

1. The Approval Process

About 50 new DOE projects are initiated annually. For Major Systems Acquisition projects, the formal review and approval process prescribes a review by the Energy System Acquisition Advisory Board (ESAAB) at key decision points including project initiation. Board members include the Under Secretary, Director of Energy Research, and other high level officials including the Assistant Secretary proposing the project. Agency representatives note that the formal decision process has not always been followed and, as a result, there is no documented data base from which to articulate some project decisions. The board has also been described as a "rubber stamp" since some projects had received approval before the board convened.

By and large, ESAAB reviews provide project proponents an opportunity to argue for project continuation. There is no audit of the data furnished by project proponents. A former board member stated that he has been outraged by projections furnished during the review process. He noted, for example, that the projections presented during one review totally ignored energy and price trends which were unfavorable to the project. Several officials believe the problem with the ESAAB process is its

assumption that individuals with a vested interest in a project can be objective. The review lacks an adequate "feedback loop" to introduce information which might question the continuation of a project from the program level to the project level.

2. Project Tracking Problems

Once projects are approved they are assigned to DOE's field operation offices for management and a project manager is appointed. Contractors, including national laboratories, are responsible for execution of the project.

DOE has established a process for managing and tracking projects based on OMB guidance and the DOD project management system. The process for tracking MSA's (projects over $200 million) requires various documentation including project plans; project management plans; project baselines; and regular written cost, schedule, and performance reports from the project manager to program and agency management. Specific principles have been established for managing major projects with prominent decisions made at the Assistant Secretary level. "Other" projects are managed at the program level or by lower level management.

A DOE headquarters activity, independent of project or program management, may review and provide its assessment of project cost, schedule, and technical feasibility. This may include independent preparation of cost estimates or the initiation of project review meetings.

DOE officials indicated the above MSA processes and reviews were developed to implement OMB guidance as well as to correct shortcomings reported by GAO in 1979 and 1981. Nevertheless, a February 1986 report by the DOE Office of Inspector General is expected to present evidence that, although responsive agency directives have been developed, the management process is still not followed; many acquisitions do not have the required documentation such as mission need statements and project plans, and required progress reports to management are routinely late or not submitted.

It is not clear that project management contributed in a significant way to the termination or current difficulties experienced with most of the projects discussed in this report. As discussed in subsequent chapters, varying programmatic, political, or budgetary causes are offered in explanation of the failed projects. Nevertheless, DOE project management was the subject of some criticism. One contractor noted that DOE has become confused between the activity of management and the records or trappings of management, i.e., its project management rules, regulations, reporting, etc. Others have stated that project management is primarily concerned with the "brick and mortar" aspects of a project, not its scientific or technical complexities.

3. Project Status Classification Problems

DOE projects have three status classifications--active, terminated, and completed. The active classification will not be addressed in this report because it was not a focus of this review. The completed group would include pilot plant projects in which DOE invested in excess of one-half billion dollars. Some of these projects were obsolete before they were turned over to commercial partners and, according to an energy analyst, not even worth the cost of labor to tear them down. The fate of these projects has been explained by DOE officials as a reasonable expectation of the philosophy which guided DOE/ERDA during and after the 1970's energy crisis.

High risk, first-of-a-kind projects were designed to develop full scale operational plants. This philosophy molded the project plans of the fossil, breeder, and fusion programs. While DOE has responsibility for building some production facilities, e.g., Rocky Flats, the primary products of many facility construction projects are not buildings. Many DOE projects are experiments/research tools, or machines used to test, discover, or verify scientific processes. Brick and mortar are not the essential components. Achieving scientific parameters determines the merit of terminating, completing, or keeping a project active.

Program officials indicated the obtuse definition of project goals makes it impossible to determine when a project is complete. "Is it any wonder," said a former DOE official, 'that DOE cannot predict cost or performance." Every project should, but does not have, defined completion criteria capable of verification. Completion determination varies from project to project. For example, (1) the Rocky Flats facility, described by some as a disaster, and which may require over $500 million to retrofit, has been reported to the Congress as "complete;" (2) the Mirror Fusion Test Facility (MFTF-B), another project which may require a costly retrofit program before it operates, was described by a program official as "essentially complete" with only funding-related problems; and (3) both GCEP, a recently terminated $3.5 billion project, and the Mirror Fusion Test Facility have been described by project management as "showpieces" or "models" of project management.

DOE officials indicated that projects such as accelerators and the present generation of fusion devices are not completed until terminated. Facility modification ends when the facility is no longer useful as a research tool. As construction proceeds, decisions can be made which would stretch performance and adapt a project for a new class of experiments not originally envisioned. It is a study in complexity, with scientists trying to drive design and systems changes during construction. In the words of some, if it is known how to design and construct an R&D facility and its performance can be reliably predicted, then there is little to be gained from the project. Others have noted that

while it can be reliably predicted that discoveries can be made with a high energy physics project, it is difficult to predict what will be discovered. One contractor official stated that DOE should be more frank in its reporting to the Congress on such projects and report on a project's scientific probability as well as on the amount of concrete poured.

The following is a list, furnished by DOE, of their recently terminated projects. Several DOE officials questioned the inclusion of the Fuels and Materials Examination Facility (FMEF) on this list since program officials said it will be completed.

Terminated Projects
(preliminary data)

Project Title (Status)	Year Started	Year Term.	Reason for Term.	Funding to Term. ($ in millions)	Total Proj. Cost ($ in millions)	Remarks
Isabelle* (Construction)	1978 2nd qtr.	1983	Technical	$201	$ 640	Accelerate/store proton beams - experimental facility.
Solvent Refined Coal I (Design)	7/19/78	1983	Administration policy shift	115	2,408	Demonstrate conversion of coal to clean burning fuel.
Solvent Refined Coal II (Design)	7/19/78	1982	Administration policy shift	110	1,950	Demonstrate conversion of coal to clean burning fuel.
High BTU: Pipeline Gas A (Design)	9/1977	1981	Administration policy shift	91	1,082	Convert coal to gas.
Pipeline Gas B (Design)	9/1977	1981	Administration policy shift	77	881	Convert coal to gas.
Low/Medium BTU: Fuel Gas A (Design)	9/1977	1981	Administration policy shift	128	881	Convert coal to gas.
Fuel Gas B (Design)	9/1977	1981	Administration policy shift	5	510	Convert coal to gas.
Fusion Materials* Irradiation Test (Design)	1978	1984	Lack of international cooperation/program shift from power plant development to more basic research	94	185	Construction of a facility representative of fusion reactor conditions to produce irradiation effect data.

*Reviewed in this report

Terminated Projects
(preliminary data)

Project Title (Status)	Year Started	Year Term.	Reason for Term.	Funding to Term. ($ in millions)	Total Proj. Cost ($ in millions)	Remarks
50 MWe Geothermal Demo, Valles Caldeora, CA (Construction/ Drilling)	1978	9/83	Technical	$ 47	$ 143	Provide information on aspects of electrical operation from liquid-dominated geothermal resources.
Enriched Uranium* Production Fac. Ohio - GCEP (Construction)	1976	1985	Competitive technology had less go forward cost, cheaper product	3,082	8,499	Design and construct a Gas Centrifuge Plant that will provide additional separate work units (SWU's).
Fuels & Materials* Examination Fac. (Construction complete/some equipment not installed)	1978	n/a	Program Shift	246	275	Alternate uses of facilities are being considered.
M-X Renewable Energy System (Design)	1980	1982	Revised basing concept DOD Mission	45	202	Concept never defined - alternate power source for M-X facilities.
ELMO Bumpy TORUS* (Engineering)	1980	1983	Technical reasons	21	145	To achieve a (Hydrogen) Plasma Confinement experiment to allow a reasonable extrapolation in evaluation of reactor potential.
Clinch River Breeder Reactor (Construction)	1972	1984	Congressional support withdrawn	1,507	3,729	Administration Breeder Project.

*Reviewed in this report

C. Project Funding Problems

Numerous interviews of DOE and national laboratory officials revealed that DOE has enjoyed creative latitude in defining project completion. This impugns the veracity of DOE claims regarding project cost overruns. Plant and capital equipment funds may be exhausted, but the project may not be what was originally advertised to Congress, nor is it ready for full experimentation. DOE officials readily admit that a project's design or scientific parameters may not be achieved for several years after plant and capital equipment funds have been expended. DOE has used operating and other funds to debug, tune-up, retrofit, and/or upgrade "completed" facilities in order to meet original or rescoped design specifications.

A senior DOE official explained that plant and capital equipment funds are viewed as funding parameters which can be ignored because cost controls are artificial barriers. A DOE official stated that, "project funds come in with different colors, DOE recolors the money to get the job done." Another DOE official stated that "DOE projects have too many pots of money leaving too many opportunities to cook the books." For example, a DOE official stated that the Tokamak Fusion Test Reactor funding profile demonstrates this. The project was completed for a reported $314 million, but admissions by a project manager indicated that in excess of $600 million was spent for its completion. Not even a budget examiner, who acknowledged this major cost overrun was true, could explain where the extra money came from. On another project a former official stated DOE discovered that in excess of $100 million of operating funds were being spent by a lab on an unauthorized construction project. When the lab was questioned about this use of funds, its response indicated it would use whatever funds were available to accomplish its mission.

D. Constituency and Advocacy Influence

One agency official noted that since projects may be overtaken by technology, programmatic, or political decisions, it is necessary that management periodically take objective soundings of a project's status, affordability, risk assessment, etc. For some projects, however, it is difficult to identify informed, impartial individuals outside the advocacy process to perform project assessments. Various aspects of DOE's project management process mitigate against an objective assessment of a project's status and technical feasibility, as discussed below:

-- The GCEP project included 12 architectural engineering contractors and 8 other major contractors. CRBR, while employing only one architectural engineering contractor, employed five contractors referred to by DOE as "prime contractors." According to one contractor official, in some instances in which DOE contracts with multiple large contractors including numerous architectural engineers on

the same project, DOE is in effect its own prime contractor. This places project management in the dual and conflicting roles of being both a buyer and seller of a project. Under these arrangements, project management may not welcome external reviews, and also, an incentive is created to control the flow of information to agency management.

-- One contractor noted that the cost plus a fee contractual arrangement between DOE and its labs contributes to a subservient attitude by some contractors. These contractors believe their fee will be based on how happy they make the field operations office, not how well they perform.

Also, a draft program is susceptible to internal advocacy influences before it is submitted for review by the administration and Congress. Internal lobbying between and among programs, with the support of labs, technical groups, etc., is part of the process. If these lobbyists are not successful within DOE, they direct their efforts at Congress. Senior DOE officials acknowledged it is a well-known fact these groups go directly to Congress with their plans.

Several officials acknowledged that once a project has been initiated, DOE has difficulty making assessments about the technical merits of a project. Until DOE utilized the Process Evaluation Board (PEB) to assess the readiness of competing uranium enrichment technologies, it was under several "illusions" created by GCEP advocates concerning the status/readiness of the advanced centrifuge machines. DOE officials said that notwithstanding the facts brought to light by the PEB reviews, GCEP's project advocates have continued to lobby for their program. One DOE official stated that since Congressional access to technical data is limited, project advocacy groups have an opportunity to "snop Congress directly to restore project funding."

E. Information Transfer to/from Congress

1. Problems in the Exchange of Information Process

DOE officials believe DOE should provide the Congress more information on project reviews, risk assessments, and recommendations so that it can more fully understand its options. They concluded that Congress is entitled to better information in order to cope with the process of voting annually in the face of a plethora of arguments on complex engineering R&D projects. An article in a 1984 scientific journal concerning CRBR stated, "through its own regularized channels of data-gatherings and analysis, Congress is not served adequately. It receives technical and scientific information sporadically."

The type of project review conducted by DOE's Office of Project and Facilities Management would clearly not suffice as they believe the Congress needs to know more than if a project is on schedule.

It was generally acknowledged that if DOE is to provide more meaningful information to Congress, DOE needs better checks and balances on the system. An improved project review process could be used for some reviews but other groups, internal or external to the agency, could be used where a more detailed review is warranted. For highly visible or controversial projects, it may be prudent to use a Process Evaluation Board-like process. This need is evidenced by numerous expressions of concern for the potential mismanagement of the Atomic Vapor Laser Isotope Separation (AVLIS) uranium enrichment project at Lawrence Livermore National Laboratory (LLNL). The concern stems from the lack of a systematic process to independently assess the data and claims which will be presented by LLNL over the next several years. The concern is not based on a lack of trust for LLNL, it is the concern of a more prudent management group which for years had been misled by claims made by proponents in such areas as the advanced gas centrifuge technology. DOE will require independent assessments of LLNL's program to determine whether the process is cost effective and, based on that decision, if there are circumstances which warrant construction of a production facility.

Establishment of a more credible and effective project review process could allay concerns for a project such as AVLIS and would result in a more fully informed decisionmaking process for DOE. This, in turn, would enable agency management to more fully inform the Congress regarding its options for project funding.

2. Lack of a Credible Information Base

a. Adapting to Change

DOE officials believe that there is a problem in the information exchange process because Congress receives convoluted data from DOE and other sources. Several DOE senior officials indicated DOE is reluctant to be fully informative to Congress. DOE would rather blame a budget shortfall for a project's delay than acknowledge a flaw in the technology. One individual summed it up by saying, "DOE just doesn't level with Congress; Congress is not misinformed, they are just not fully informed."

A DOE official suggested that once a project gets funded, it becomes virtually unstoppable, although its justification, design, or priority may have gone through several iterations beyond the scope of Congressional review. An example of this was the Rocky Flats project. DOE's funding request for this facility indicated plutonium production would be the overriding consideration to guide decisionmaking. But as one DOE

official stated, "DOE forgot it needed a production facility," and the Rocky Flats project was transformed into an R&D venture. DOE's health and safety personnel shifted facility emphasis toward a safer, more automated working place. The end result was the development of a safer but virtually inoperable production facility.

Similar circumstances cloud the decisionmaking process for other projects; circumstances the Congress would not necessarily have been aware of. For two projects the initial justifications for their funding dissolved (CRBR--lack of uranium reserves; GCEP--need for additional enrichment capacity). Nevertheless, forces within DOE sought to develop new justifications to sustain these projects. According to several present and former DOE officials, even when unforeseen events made it impossible to justify these projects in a changed environment, DOE was reluctant to give up the money approved for them. These and projects like them became technology driven, and dependent on internal and external constituencies to sustain their momentum. ERAB cited two major difficulties in terminating programs:

1. In order to get a new federally funded R&D program started, it is usually necessary to build both a technical and a political constituency for the program. As the self interest of the various constituencies grows, a program can prosper. However, when the technical program is completed or no longer technically or economically attractive, the self interest of the constituencies may keep it going for years at great expense to the taxpayer.

2. Many times the inertia of the initial commitments is overtaken by new technical information or the need for the project goes away as national needs change. But, because of the inertia of these commitments, program directors do not take appropriate action to terminate these programs and thus they are continued.

For some projects, advocates push the political process ahead of the technology. Senior DOE officials identified the high energy physics group as the external constituency with the highest visibility in this area. This group has tried to build a groundswell of political support for two of their projects before DOE had an opportunity to discuss its options. Whereas senior DOE officials indicated one of these projects will not be elevated to a serious discussion level before the 1988-89 time frame, high energy physics constituents are promulgating information that the project will be approved. Senior DOE officials suggest the premature politicking of groups like the high energy physics community, and the dissemination of misleading information, is disruptive to DOE's program infrastructure.

DOE officials defensively suggested that Congress may be misled more by project proponents than by DOE. Lobbying by national laboratories, technical groups, and industrial organizations was identified by a DOE official as undermining DOE program management and hurting overall program strength. Several DOE officials stated that funding for projects like the High Temperature Gas-cooled Reactor and metal fuels was the result of independent lobbying efforts and demonstrates a repudiation of the energy program plans formulated by DOE.

b. Congressional Feedback

DOE officials stated that they, too, have had trouble with the information exchange process. The difficulties stem from trying to interpret Congressional intent. As an example, some DOE officials stated that they believe Congress withdrew funding support for CRBR because it wanted a burgeoning breeder program capable of "leap frogging" the demonstration scale project. However, other DOE managers interpreted Congressional maintenance of substantial funding for breeder R&D as an endorsement of the existing direction and scope of the program.

Others in DOE were less clear in explaining Congressional intent with respect to CRBR or other issues. These officials believe that Congress has oftentimes sent mixed signals on DOE programs. In the AEC era there was one joint committee to speak for Congress; now, according to one report, there are 22 committees responsible for providing direction for DOE programs.

IV. BUILDING 371--ROCKY FLATS

A. Project Development and Management

Building 371 was approved by Congress in 1970, with an estimated cost of approximately $113 million. Construction began in May 1973, with an original completion date targeted for December 1975. Building 371's original contractor was replaced in November 1976 due to severe construction delays, and its completion date slipped to March 1978; it later slipped to February 1979.

Building 371 suffered from severe flaws in design, management/construction, and testing, thus earning it the reputation as a "plumber's nightmare." The net result of these flaws was a production capacity of only 7 to 8 percent of that originally estimated, and a cost overrun of approximately $102 million. Originally Building 371 was to be a production facility, but in time the project became more of an R&D effort.

1. Design

The design of Building 371 probably had more influence on its failure than any other cause. Simply stated, the design was incompatible with the output requirements and, therefore, the facility was, in the words of a DOE official, "born to fail."

Building 371 was designed using, and in some cases exceeding, the then current state-of-the-art methods in remote handling techniques. As noted earlier, one of the driving forces behind the project was enhanced safety for the employees which necessitated remote handling. Most design data came from AEC headquarters, DOE's Albuquerque Operations Office, and the Government contractor because there was a lack of commercial experience in plutonium handling.

Another driving force in the design process was AEC's health and safety requirements. One former DOE official stated that the health and safety aspects of Building 371's design became so influential that it actually became more important than the production aspects. This caused certain processes in Building 371 to exceed the then current state-of-the-art. Additionally, the changing health and safety requirements necessitated design changes, thereby driving up costs.

Existing technology was also exceeded in the design of the project's fluorine-based processes. The technical risk of this approach was recognized by the designers and a small pilot plant was established and successfully tested this concept. However, when applied to full production in Building 371, the operation did not scale up in a linear manner as had been expected. Cycle times were found to be three times longer than anticipated and the installed valves were corroded by the fluorine process. Another major design flaw was the apparent lack of system maintainability.

One DOE official advised that some on-line maintenance required complete system shutdown which further reduced annual throughput capacity.

2. Management/Construction

During the initial phases of construction, the contractor, the Lummins Company, was unable to achieve desired construction goals. Hindsight has shown that this was probably the result of inadequate on-site management by the AEC. The AEC expertise was reactors, not plutonium recovery, and it depended heavily on the management expertise that had been "bought" with Lummins. AEC's oversight came from headquarters in the form of "flying squads" of headquarters personnel. There was also an on-site AEC manager from the nearby field office. However, he had no decisionmaking authority and was not a full-time manager because he also had responsibility for other projects. Construction delays became a serious problem and Lummins was replaced by the Swinerton & Walberg Company. At the same time, AEC provided on-site management in the form of an outside expert who responded directly to DOE's Albuquerque office.

Due to the near catastrophic results of the 1969 fire, AEC designated Building 371 to be an urgent "fast track" project. This resulted in severe cost and schedule overruns. The urgency of the project resulted in the lack of an integrated schedule to identify the relationship between design, procurement, and construction. Consequently, design and construction proceeded along parallel paths and many pieces of equipment were procured too early and "were left sitting out in the fields to rust." DOE also said the fast track approach did not allow adequate time for systems testing and pilot plant studies.

When it was realized that Building 371 was not going to be completed within budget, cost-cutting measures were implemented to the further detriment of the project. Some reported examples of cost cutting were:

-- substituting carbon steel for stainless steel,

-- substituting plastic piping for an exotic metal alloy,

-- reinforcing walls with wallboard, and

-- inadequate systems testing.

The testing of Building 371 systems began in August 1978, and was completed in September 1980. The testing procedures, without the presence of plutonium, were supposed to simulate the environment of the "hot process." DOE's usual method of testing is a set of procedures related to project reliability, availability, and maintainability. There are allegations these procedures were not followed. Officials stated that the facility was tested piecemeal rather than as an integrated whole.

Apparently, each module performed as specified when tested separately in a batch mode, but when the whole system was integrated in a "hot" environment the various modules would not properly interface, resulting in breakdowns.

B. Future Prospects

Building 371 cannot be considered a complete failure. It does produce plutonium, though on a much reduced basis. Because of its reduced capacity, Building 371 has been shut down until alternatives can be studied. The current outlook for Building 371 appears bleak from a cost point of view. DOE is planning major renovations to the facility to improve its production capability. Estimates of future cost range from $295 million to $563 million with the low figure being DOE's estimate and the high figure being the Government contractor's estimate. This would bring the total cost for Building 371 to somewhere between $531 million and $799 million. A GAO study found that the renovations based on DOE's low estimate would only bring the facility up to 58 percent production capacity and the high figure would bring it up to 87.5 percent capacity. The renovation schedule for Building 371 begins in FY 1988 with a suggested 6-year length.

1. Legal Estoppel

There is no legal recourse against any contractor involved with the Building 371 project. According to DOE, the design and construction of Building 371 utilized both cost-type and fixed-price contracts. The fixed-price contracts covered basic construction of the project's externals, such as the building shell, substructure, etc. The Government concluded that this work had no adverse effect on building utilization. The cost-type contracts accounted for the balance of Building 371 including such key areas as design, procurement, inspection, installation of process equipment, etc. In regard to these contractors, "* * * any liability of a less than full utilization of Building 371 must be based on proof * * * that the contractors' managerial personnel * * * were guilty of willful misconduct or lack of good faith * * *."

2. Plutonium Processing--Special Isotope Separation

DOE states that the future need of plutonium exceeds its current capabilities. In this regard, a new process to obtain weapons-grade material is being considered--the Special Isotope Separation (SIS). However, an earlier Investigative Staff report on nuclear materials production identified a concern that DOE's projections for plutonium requirements were faulty. Another concern is that Lawrence Livermore National Laboratory (LLNL) is pushing too hard for SIS and wants to deploy a production facility

based on laboratory-scale experiments without benefit of prototyping. This attitude, according to one lab official, could result in SIS having problems similar to those encountered with Building 371.

The above concerns were addressed in a report by a distinguished group of academicians called JASON. The report stated that to a certain extent the need for plutonium is real, especially when one considers the weapons modernization programs and a Presidential mandated reserve. JASON believed that a laser-based SIS plant was the best way to obtain plutonium for three reasons:

-- The cost of an SIS plant would be substantially lower than the cost of a new production reactor with a comparable lifetime output.

-- Without an SIS plant DOE might be required to produce weapons-grade plutonium by blending supergrade plutonium with fuel-grade, thereby polluting the cleanest plutonium in our stockpile with radiologically harmful isotopes.

-- An SIS plant would provide valuable technical knowledge for potential future industrial applications of lasers.

JASON strongly recommended against the deployment of a full production SIS before a "prototype plant has been evaluated in operation for cost effectivenss and maintainability in an industrial environment. We are not persuaded that the need for more weapons-grade plutonium is so critical that an accelerated implementation of SIS technology is needed."

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V. THE GAS CENTRIFUGE ENRICHMENT PLANT

A. Project Development and Management

In 1974, the AEC supplied enriched uranium for all domestic markets and almost all of the foreign markets outside the Communist world. In 1974, projected demand for U.S. enriched uranium was so high AEC closed its order books. All its available enrichment capacity was projected to be firmly committed by the early 1980's. Therefore, in December 1975, the Congress authorized construction of new enrichment capacity at Portsmouth, Ohio, to permit reopening of the order books. Originally, the new plant was to use the proven gaseous diffusion technology but on April 20, 1977, President Carter announced that new gas centrifuge technology would be used instead.

The Gas Centrifuge Enrichment Plant (GCEP) was originally planned to consist of tens of thousands of centrifuge machines, each with an annual production capacity of 200 Separative Work Units (SWU's). In April 1978, because of reduced demand projections, DOE decided to build only the first 2.2 million SWU increment of the plant by 1988, and slipped the completion date for the entire 8.8 million SWU plant from 1988 to 1994. At the time it was terminated in 1985, total project cost was projected to be $8.5 billion, with $3.5 billion--including $.9 billion imputed interest--already invested.

Currently DOE officials have suggested that from its inception the decisions which molded this project were not business oriented. GCEP was a product of technological decisions. This was reflected in the design to use centrifuge machines for GCEP, which were to be bigger and better than European models. The European centrifuge program was capable of deploying cheap, replaceable 100 SWU machines. The decision by DOE management to extend the centrifuge technology resulted in the United States pricing itself out of competition in free world markets.

1. Justification for GCEP Changed

In 1980, GAO reported it was not apparent that even the first 2.2 million SWU increment of the GCEP facility was needed. GAO partially based this conclusion on the dramatic decrease in foreign and domestic demand for U.S. enrichment services since December 1975, and DOE's plans to reduce production at its gaseous diffusion plants in the 1980's to only about 36 percent of capacity. In other words, it did not appear that DOE could justify GCEP on the basis of demand for U.S. produced enriched uranium.

As a result, DOE changed its justification for GCEP to one of long range economic benefits. While GCEP was capital intensive, it would use only about 5 percent of the power required by the gaseous diffusion plants to produce an equivalent amount of enriched uranium. Project proponents thus justified GCEP on

the basis that it would be more economical than continued operation of the gaseous diffusion plants, especially if projections of increased power costs were accurate. These projections were not accurate, but the gaseous diffusion plant program was then, and is still today, committed under contract to pay for power to operate the plants. These contracts are not based on consumption but instead require DOE to purchase an agreed upon amount of power. If DOE does not use the power contracted for, it pays a penalty known as a capacity charge.

With gaseous diffusion plant power costs predicted to make U.S. SWU prices less competitive, DOE believed it should construct GCEP, regardless of demand, because the plant would significantly reduce the long range cost and price of SWU's, thereby enhancing its competitive world market position.

In another attempt to justify the centrifuge program based on economics, DOE began to develop Advanced Gas Centrifuge (AGC) machines. The objective was to develop a centrifuge machine capable of producing larger numbers of SWU's. It became apparent that in order to be economical, DOE would have to develop a 600 SWU machine suitable for installation in the originally designed GCEP facilities.

2. Project Management

At the time GCEP was approved, the projected demand for U.S. enriched uranium and the U.S. share of the world market began a precipitous decline which continues today. In 1974, the United States held, based largely on future requirements, a virtual monopoly in uranium enrichment. In 1978, for example, the United States was supplying enrichment services for less than 100 reactors but had contracts for about 350 reactors. DOE estimated, in 1974, that the demand for U.S. enriched uranium in the year 2000 would be 150 million SWU. However, this projection steadily declined to about 70 million in 1978, less than 50 million in 1980, and in 1985, DOE estimated SWU demand in the year 2000 to be about 20 million.

During this period, DOE did not recognize the changing economic and demand conditions, including cancellation of nuclear plant orders. Project advocates continued to make demand projections in support of GCEP continuation despite a high level official's admonition that the data used to justify GCEP was outdated. The degree to which projections made during this period exceeded actual sales can be seen from the following DOE projections.

	Projection When Additional Capacity Was Authorized (December 1975)	Projection When Decision Made to Defer 75 Percent of GCEP Capacity (April 1978)	Projection March 1980	Actual Sales
	millions of SWU's			
1980	26.0	18.3	11.2	10.7
1985	37.2	38.5	24.0	10.2

During the same period the U.S. share of the free world market declined from 100 percent in 1974, to 74 percent in 1979, and 47 percent in 1985. These events are, in large part, attributable to competition from European and Soviet Union suppliers brought on by the United States closing its books in 1974, U.S. proliferation policies, dramatic reductions in the projected growth of nuclear power, and the noncompetitiveness of the U.S. price. Until 1981, DOE was the lowest price supplier in the world but by 1985 the DOE price was $135 per SWU and was 30-40 percent higher than its European competitors.

Reductions in the growth of nuclear power in the United States can be seen from the chart below.

Nuclear Power Plant Orders vs. Cancellations

Year	Nuclear Plant Orders	Cancellations
1972	38	6
1973	41	0
1974	26	8
1975	4	11
1976	3	2
1977	4	9
1978	2	13
1979-1985	0	63

Knowledgeable individuals offer explanations for how a technically questionable, marginally economical, and very costly project initiated to increase production capacity could proceed so far without ample justification. The explanations include a general lack of leadership at high levels of Government combined with erroneous and misleading agency representations.

At its inception, GCEP was justified on projections of significant increases in demand for U.S. produced SWU's. Former agency officials stated that the lack of anticipated demand was obvious to agency management not later than 1978. Accordingly,

early in the project, agency management made an effort to terminate it. However, due to the politically sensitive nature of GCEP, the administration failed to exercise the leadership necessary to terminate the project.

Various individuals advised that the project advocates lost their objectivity regarding the merit of the project, controlled the flow of information regarding the project, and used outdated economic data to justify it. The lack of accurate project information is, in part, attributable to the inability of DOE management to conduct technical project reviews, DOE's reliance on project advocates for performance assessments, and the general tendency of DOE to oversell its projects. The program appeared to be driven by production and technology decisions to the exclusion of market place considerations and eventually the SWU inventory grew to equal 3 or 4 years demand.

Additional insight into the inadequacies of the program's management can be gleaned from the 1984 House Tri-Committee Business Advisory Panel review of the business aspects of the program. This panel of business experts recognized that DOE had recently begun to deal with the realities of the marketplace, but found that DOE should accelerate the additional improvements necessary to move from a technology driven to a market driven mode of operation. Business shortcomings were addressed in a series of recommendations including the need to:

-- Establish specific written business objectives for the program, including goals for sales, cost, etc.;

-- Increase involvement of outside business and financial advisors in managing the program;

-- Obtain relief from OMB and the Congress from the zero net annual appropriations for the program;

-- Have all Process Evaluation Board activities reviewed by independent financial and business advisors; and

-- Establish a private business management structure for the program.

With respect to the latter recommendation, the panel noted that the prospects for a private business management structure were uncertain but highly desirable.

B. The Process Evaluation Board

Having already lost foreign markets, DOE started to lose domestic markets. This increased economic pressure on DOE's uranium enrichment program and cast doubt on the ability to sustain the growth of GCEP and other aspects of the program. In 1983, under new program management, DOE began to assess the fiscal implications declining revenues and escalating costs would have on GCEP and the advanced developmental technologies. Accordingly, in mid-1984 at the request of the Secretary, DOE convened a Process Evaluation Board (PEB) to assess two advanced uranium enrichment processes: (1) The Advanced Gas Centrifuge (AGC) process, with 600 SWU machines which could be deployed at the GCEP facility, and (2) the Atomic Vapor Laser Isotope Separation (AVLIS) process. AVLIS had been recommended over other laser isotope separation processes for further development. While AVLIS offered the promise of producing SWU's more economically than the centrifuge process, only the scientific feasibility of AVLIS had been established at that time.

Neither the original GCEP machines nor the gaseous diffusion plants were assessed by the Board. DOE was reviewing those programs separately. The Board was to make its recommendation concerning the two competing advanced technologies. The Secretary wanted to make a technically based business decision and select one technology for potential future deployment on a large scale. The Secretary realized that a lack of fiscal responsibility by program management made it impossible for DOE to continue all enrichment programs. It was estimated, for example, that program costs would exceed revenues by $1 billion annually over the next 5 years if AGC/GCEP had been continued. The Secretary anticipated that the board would furnish evidence, which would be available for Congressional review, to support DOE's program decisions.

The Board consisted of seven DOE employees and was assisted by contractor support. While the Board members were not experts in the technical areas, they have been described as becoming experts in assessing the technologies. The process was adversarial, with the Board acting as a jury. Advocates of each technology acted as the defense for their candidate and as prosecutor for the competing candidate.

Board members entered the process under the assumption that AGC technology was developed. However, they soon learned that AGC proponents' claims could not be taken at face value. Officials familiar with the Board's process stated that only about 25 percent of the costs AGC advocates claimed as nonrecurring were determined to be nonrecurring. The same officials noted that DOE talked about the AGC technology as though it were in-hand and project engineers believed the new 600 SWU machines could be obtained through simple engineering extrapolations. The Board found, however, that AGC would require scientific breakthroughs on several fronts and, indeed, was only marginally more economical than the 40-year old gaseous diffusion process.

The Board highlighted some interesting aspects of both DOE program and project management. Programmatically, the gaseous diffusion plants were not viewed as part of the competition for SWU production because DOE management still believed these plants would be phased out of operation. Once the Board process started, gaseous diffusion plant advocates tried to enhance their operational efficiency. A DOE official stated that a 6-minute meeting produced a decision which led to changes in the plants' operating cycles and savings of 30-40 percent in electrical power usage. Prior to the PEB contest, former program management devoted very little attention to cost discipline. A DOE official believes former management had created the myth that GCEP was a "public works project" costing the taxpayer nothing.

At the project level the Board called attention to DOE's failure to properly audit the technical claims of the labs developing the AGC. Officials indicated a concerted effort by project developers had created false impressions concerning the readiness of the technology and hindered the reporting of any information which might reflect unfavorably on the AGC. Officials also stated that efforts by employees to report accurate data were restrained.

C. Future Prospects--Atomic Vapor Laser Isotope Separation

In May 1985, the Process Evaluation Board reported that:

-- Neither the AGC nor AVLIS process could be deployed on a large scale without further R&D;

-- The AGC technology represented major extrapolations of technology and successful demonstration of even R&D centrifuges had not yet been accomplished; and

-- AVLIS had the greater potential for low cost and reliable production of SWU's and could be supported within anticipated enriched uranium revenues while AGC would require appropriated or other financial support.

In June 1985 DOE terminated both GCEP and AGC, about 8 years and $3.5 billion after initiation. AVLIS was selected as the technology of the future and the two post World War II era gaseous diffusion plants continue to supply the U.S. enriched uranium needs in the near term. DOE believes the old gaseous diffusion plants will offer stern competition for AVLIS. There is speculation that after a 3 to 5 year trial period, AVLIS, like AGC/GCEP, may not be able to significantly beat the gaseous diffusion plant price. What that portends for the AVLIS program is a current concern of DOE management.

Concern has been expressed that the GCEP fate might befall AVLIS unless more informed management attention is brought to bear. While AVLIS has demonstrated the capability of processing uranium ore, its economic production capability must still be expressed in terms of its potential. A proposal to begin operations of a demonstration plant in FY 1988 is being assessed by DOE. Development cost of AVLIS for FY 1986-89 is estimated to be $388 million.

The AVLIS project is not justifiable on demand projections, but rather as a potential means to significantly reduce production costs thereby allowing the United States to regain some of its lost market. Accordingly, DOE management will be faced with major business decisions on the AVLIS program such as when to deploy and, if so, where and how. The two major options for deployment are (1) deploy when AVLIS demonstrates production capability at a cost equivalent to the diffusion process and continue technological improvement to drive down the cost, or (2) continue R&D in a lab environment until the cost is driven down and then deploy. The longer AVLIS is kept in an R&D status the more costs the project incurs without contributing to revenues.

It has been proposed that the technical claims of AVLIS personnel be independently investigated prior to a deployment decision, and that a panel, board, etc., be instituted to obtain expert advice on the business and market related aspects of AVLIS deployment. Program officials have stated that, consistent with the lessons learned from GCEP/AGC, two advisory panels will be established in 1986. One panel will consist of industry experts in various technical fields to regularly assess the technological progress of AVLIS. A second panel, to be comprised of industry representatives, will advise on business strategy including deployment.

VI. THE CLINCH RIVER BREEDER REACTOR AND FUELS AND MATERIALS EXAMINATION FACILITY

A. The Clinch River Breeder Reactor

The AEC, as part of a national energy strategy, developed a nuclear reactor program which was well supported by utility and industrial groups. Included in the program were several large breeder projects including the Clinch River Breeder Reactor (CRBR). CRBR was a joint venture supported by a consortium of 753 utilities who had agreed to contribute $257 million to the project.

1. Project Development

The initial program first called for the construction of a Fast Flux Test Facility (FFTF), followed by construction of CRBR. The purpose of developing the FFTF was for irradiation testing of advanced fuels and components. It would not breed or produce electricity, but it would serve as a stepping stone in the design of CRBR. Unfortunately, as breeder projects were developed, the AEC failed to recognize the criticality of time and sequence for the breeder program. Delays on the FFTF pushed the early program back 2 years. Thus, the plan to utilize FFTF as a learning experience for CRBR was lost. A decision was made to forego sequential order; CRBR was to be designed and constructed in parallel with FFTF. DOE officials said CRBR and the entire program became the victims of trying to accomplish too many objectives in parallel, e.g., trying to concurrently develop the basic technology, safety, and construction codes and standards, and an industrial base for the program.

2. Project Management

There have been several reports written about the management of the CRBR project. A 1980 DOE Office of Inspector General (IG) report stated, "the project was well managed." This contrasts to another IG report in which CRBR management had been described as "out of control."

AEC imposed a multi-layered, pyramidal management structure for CRBR. Program officials indicated the products of this structure were long, cumbersome communication paths to and from the contractors, and project delays. It was a system where management was by compromise and committee. An employee of one of CRBR's major contractors said, "the process for getting approval for a simple design change could literally take months to complete."

At the top of the pyramid was AEC project management--Headquarters at Germantown. AEC's role was dominant. Their senior management was described by a DOE internal memorandum as obsessed with a sense of mission and pursuit of quality. Cost factors and construction progress were subordinate to quality assurance.

At the base of the management pyramid, AEC organized an industrial participation scheme which permitted every major contractor a "piece of the action." Westinghouse Advanced Reactor Division was responsible for the nuclear steam supply system, General Electric was responsible for detailed component design, and Atomics International was responsible for fabrication of the steam generators. In addition, Burns and Roe, Inc., was the architect engineer, while Stone & Webster Engineering Corporation was responsible for construction.

Program officials suggested that even after project management shifted from Germantown to DOE's Oak Ridge Regional Office, things were little improved. In the words of a senior DOE official, AEC had created a project community which was without precedent.

In 1974, AEC developed the first cost estimate for CRBR based on a complete examination of design requirements. This estimate raised CRBR's cost from $699 million to $1.7 billion. Through the mid-1970's, CRBR's expenditures would increase until it accounted for nearly half of the entire breeder program budget. After 1974, CRBR's cost estimates were revised at least six times and it became the Government's largest nondefense project. A significant cost driver for the project during this time frame was the unanticipated expense necessary to comply and keep apace with newly issued safety, environmental, and regulatory criteria. Project designs and component specifications were constantly in flux because criteria were being prescribed in parallel to project development.

3. Effects of Administration Changes

The Carter administration opposed construction of CRBR because of concerns over nuclear proliferation. Breeder fuel contains plutonium which can be used to make nuclear weapons. By stopping CRBR, the administration believed it could forestall the development of breeder reactors abroad.

Congress, however, disagreed with the Carter administration's decision to kill CRBR and continued to fund the project. CRBR moved from a demonstration project to a national commitment, and it came to represent Congressional will to support nuclear power.

The clash between the Congress and the Carter administration earned CRBR the reputation of a "political football." The project's political coloration made it difficult to attack CRBR successfully on rational scientific grounds. Lost in the debate over CRBR was a recognition that original project assumptions and justifications were no longer valid.

During this time, DOE project management was compromised by project constituencies. Components were bought, built, tested, retested, and stockpiled for a reactor there was no license to

build. Every system was rescoped, redesigned, or re-engineered. According to a former DOE official, even the labs took advantage of these circumstances by improperly "hanging several $100 million worth of nonbreeder related R&D on CRBR."

When the Reagan administration took office, it inherited a management structure which DOE officials characterize as "out of control." There was no cost discipline. A DOE senior official said cost overruns were as much a reflection of bad management as inflation. Officials indicated the project management inherited by the new administration attempted to raise total project cost estimates by another $500 million. Officials stated that the lack of discipline on CRBR was the reason the new agency administration replaced several project staffers. This "shake-up" was an effort to bring some accountability and cost responsibility to the project.

4. Closing Out CRBR -

By 1982, CRBR's design was 90 percent complete, over $350 million in components were delivered, and construction was scheduled to start in 1984. Nuclear proliferation was no longer an issue. However, there was a shift in attitude caused by a recognition that many of the justifications for a breeder reactor had disappeared. Growth in demand for electricity had declined from 7 percent a year in 1972 to less than 3 percent. Near term predictions of uranium shortages had been dispelled, and uranium prices had plummeted from $40/lb. in 1980 to less than $20 by 1982. The price at which a breeder becomes economical is $150/lb. Congress recognized that these factors and the significant drops in projected use of nuclear power had made the technical value of CRBR obsolete.

The singular accomplishment normally attributed to the CRBR project is that it demonstrated the licensibility of a breeder reactor. The Atomic Safety and Licensing Board issued a limited work authorization for the project in March 1983. The project's official termination date was 8 months later, November 14, 1983. As of the last project report dated June 20, 1985, DOE was still terminating the project. That report included close-out costs of $2.3 million to relocate large CRBR components.

B. The Fuels and Materials Examination Facility

With artificially created demand projections and political confusion over the CRBR project, opportunities arose to propose new breeder support facilities. In keeping with existing administration policies regarding nonproliferation, commercial fuel fabrication became administratively unpopular. FFTF was buying fuel from three private manufacturers and a decision was made to get private industry out of the fuel production business. In 1978, Congress appropriated funds and authorized construction of the High Performance Fuel Laboratory with a total project cost of $109.3 million. The laboratory was envisioned as a safe,

automated, hands off, fuel fabrication facility primarily serving FFTF. Congress also authorized the Fuels and Materials Examination Facility (FMEF) at a total project cost of $172.6 million. FMEF was designed to examine irradiated fuel assemblies from FFTF and CRBR. Both the laboratory and FMEF were to be located at the Hanford Engineering Development Laboratory, Richland, Washington, near the FFTF project.

In 1980, DOE submitted a combined project plan for the High Performance Fuel Laboratory and FMEF at a total cost of $275.4 million. The combined facility would house post-irradiation examination equipment but would not include fuel fabrication or assembly equipment.

1. Project Development and Management

Officials at Richland indicated that problems existed early on with the project. From the outset DOE failed to issue a clear policy statement for this examination facility. In addition, program officials suggested FMEF went through many modifications, program changes, and baseline adjustments. By conforming to the ever-changing guidance coming from DOE, things were built into the facility which would make additional changes almost impossible. In addition, Richland officials said that while activity on CRBR was slowing, DOE continued to put equipment under contract for FMEF. It was reported that at least $20 million of this equipment has never been used but is kept in warehouses near the project site.

At the program level, DOE officials stated that, as late as 1983 with the project almost complete, management still did not know what equipment to install in FMEF. A 1984 project assessment report stated, "This project could become an embarrassment to the Department unless we fully define its function and ensure it does not continue being modified."

2. Concern Over Project Utilization

There is disagreement concerning how much of this structure is being utilized in a meaningful manner. DOE records indicate the total utilized floor space in FMEF is about 60 percent. The majority of this utilized space is facility support areas, e.g., maintenance shops, security, etc., and entry wing space, e.g., lunch room, conference rooms, offices, janitorial support areas, operating corridors, etc.

DOE officials said FMEF will be used as a support facility for FFTF. FFTF remains the most modern, powerful, and flexible high flux test facility in the world. Richland officials, however, caution that for the small number of tests performed in FFTF, its cost benefit ratio is not what was envisioned during the breeder program's heyday. There were suggestions that if international support was not developed to support FFTF programmatically and

monetarily, fiscal sensibility could force DOE to close it down. The fate of FMEF will depend on what happens to FFTF. Richland officials said Congress should closely monitor the future utilization and costs for both FFTF and FMEF.

C. Future Prospects--The Strategic Plan for the Nuclear Program

The termination of the CRBR project took away the "flagship" for DOE's reactor program. Several senior DOE officials believe that losing the CRBR left the nuclear program in shambles. This program, which has been without the leadership of an appointed assistant secretary since September 1984, has been described as hopelessly adrift, without focus, and generally in chaos. An industry representative said foreign programs are disappointed, because DOE cannot explain what its breeder program is or will be.

The plight of the program was forewarned as early as 1980 by GAO which reported the breeder program lacked a clear mission and focus which could result in a considerable waste of money and time. GAO also questioned the capability of the program to adapt to commercial use. From the perspective of other DOE program officials, the nuclear program was intended to be market/user responsive, but for years it has been viewed by many as primarily a guaranteed employment program for some research labs.

1. Objectives of the Strategic Plan

Current senior DOE management, taking direction from a House Appropriations Committee conferee request for a plan to identify the funding priorities for future reactor concepts for the civilian nuclear reactor program, has drafted a strategic plan for this program. Even before the plan has been reviewed and implemented, critics have suggested that internal project advocates and the labs will discourage trying to tie nuclear R&D to market realities.

To overcome internal biases, the Secretary has asked the Energy Research Advisory Board to review this plan to recommend any changes or modifications based on the input of user groups, utilities, and environmental groups. Market analysis will guide the plan and the plan will guide the program. DOE senior management indicated the Board's review will provide marketplace support for the plan, which is necessary if its purpose is to focus Government funded R&D toward a single advanced reactor system.

Once the Board's review has been completed, the approach for carrying out the strategic plan may include a Process Evaluation Board-type assessment and review of the candidate reactor systems. A rational decision making process will assess the relative technical, economic, and other potential advantages of the various candidates.

2. The Strategic Plan--What It Forebodes

Both industry representatives and DOE officials portend the success of the strategic plan will depend on Congressional support. The plan represents a radical departure from the existing mode of operation; programs will have to be terminated and labs closed. Labs will no longer be able to argue the merits of their projects if they do not complement the commercial focus established through the plan. According to an Energy Research Advisory Board member, adoption of a focused plan is a national imperative in order to avoid the diffuse paths dictated by lab programs. Some of the current lab reactor proposals would require multi-billion dollar Government commitments to commercialize reactor concepts the nuclear marketplace would not buy.

DOE management and lab officials said that one area which surely will find itself subject to budget cutbacks will be the fuel cycle programs. Argonne National Laboratory recently resurrected a 20-year old issue regarding the practical and economical use of metal fuels. Currently DOE is funding a metal fuel feasibility study which will cost upwards of $50 million through FY 1989. DOE officials said that if the strategic plan works as advertised, the fuel cycle issues can be resolved based on safety, cost, and market criteria. Whatever the results, DOE officials indicated a choice will be made. The net result will be closing programs and facilities which do not support the winner. The practical aspects of closing these programs is something DOE management expects will be challenged.

Industry representatives believe DOE's plan is a very significant opportunity to resolve the dilemma created when CRBR was terminated. If DOE is successful through its strategic plan and restores a commercial orientation to the program, industry representatives believe the size, breadth, and cost of DOE's program will be greatly reduced. Today's fiscal and energy climates cannot justify a multi-hundred million dollar nuclear R&D program. Industry and DOE officials believe a budget scale down will be necessary because current energy projections do not forecast a clear and imminent need for advanced reactor technology before the year 2020 or beyond. In the interim, these officials suggested reactor technology should advance in two directions. First, the existing light water reactors should be made to work more efficiently and economically. Secondly, the reactor program should attempt to cooperate and collaborate with foreign reactor programs. The U.S. program has access to Japanese technology for what may be a licensable advanced light water reactor and plans to participate in a planned German-French breeder project to learn the "how to's" of breeder construction.

3. The Strategic Plan--Problems It Does Not Address

DOE officials acknowledge the strategic plan is not a panacea for the U.S. nuclear program. The reason the United States needs a significantly smaller reactor program is because, as a former senior DOE official stated, "all the R&D isn't worth much if the institutional problems which plague U.S. nuclear industries are not resolved." An article in Nucleonics Week, commenting on the draft strategic plan, observed the plan does not address the institutional and economic barriers to nuclear power in the United States. The Nuclear Regulatory Commission, public utility commissions, adverse public opinion, the costs associated with reactor construction, and litigation expenses, are some of the perceived obstacles to nuclear development. The consensus among industry representatives was that DOE's program should be focusing on such issues as regulatory reform, one-step licensing, and standardization of design for LWR's.

VII. THE MIRROR FUSION TEST FACILITY AND FUSION MATERIALS IRRADIATION TEST FACILITY

A. The Mirror Fusion Test Facility

The Mirror Fusion Test Facility (MFTF), a Lawrence Livermore National Laboratory (LLNL) project, was authorized in 1978 as a single-cell mirror facility at a cost of $132.5 million with a completion date of September 1981. In 1980, the project was rescoped to the present, more technically complex tandem mirror concept (MFTF-B). The projected cost at the time of rescoping was $316.5 million. In July 1985, the project cost was raised to $445 million.

At the time MFTF was rescoped and became MFTF-B, fusion review panels recognized there were at least three technical aspects to the project which represented advances beyond state-of-the-art technology and represented the highest technical risk to the project. MFTF-B had to be designed properly to be "successful" and meet established criteria.

A 1980 Energy Research Advisory Board report states, "We believe that such a step is now warranted and we recommend it * * * the MFTF-B will require extensive supporting developments in physics and in technology, and * * * should be paced to accommodate results from the tandem mirror experiment program as design verification check points". Thus, MFTF-B was viewed as the appropriate-sized step in the fusion development process.

A 1980 fusion review panel indicated considerable momentum had been established for this project. This was due in part, to DOE's policy that by 1988 it would endorse either the mirror or tokamak concept for reactor development. To be successful in this competition, MFTF-B would have to demonstrate the viability of the mirror configuration and provide evidence that it, not the tokamak configuration, offered greater potential for reactor development. Since the tokamak program was already well ahead of the mirror program in terms of development, it was unrealistic to believe MFTF-B could be paced to accommodate mirror program R&D, and meet its programmatic goals within the time allotted. Thus, MFTF-B project proponents put the project on a schedule which ignored the state of the technology. R&D was placed in parallel with construction while design was initiated before verification had been obtained from another mirror project. Former DOE officials now admit their endorsement of the project was premature and there was no reason to rush MFTF-B before the development of an adequate scientific base.

1. Project Management

A 1983 DOE IG report stated MFTF-B, "is considered one of the best managed projects in the Department." The Office of Energy Research and others frequently use this project as a learning model for management practices, in spite of the fact that the estimated date for project completion slipped from 1984-1988.

The basic procurement policy for MFTF-B was to procure competitively the components and systems from industry using negotiated firm-fixed-price contracts where feasible. Cost-type procurements were issued where appropriate in the R&D areas. In the conventional construction areas, advertised competitive fixed price procurements were followed. The IG did indicate that some capital equipment not related to construction was purchased for the project, but was not properly budgeted, accounted for, or controlled on the property records. Laboratory policies were inconsistent with DOE policy and demonstrated a lack of control over accountable property in its possession.

While cost and milestones were proceeding on schedule, some of the physics problems had not been remedied. There was some indication that since 1983, the laboratory had been aware of design problems but did not publicize it for fear it would mean shutting down the MFTF-B project. During 1984, LLNL began disclosing to physicists within the fusion community that problems existed with the data from a related mirror experiment. This data implied successful experimentation might not be achieved in MFTF-B because of its present design. Several DOE officials stated that "if Congress is to get what was advertised, the design and other problems would have to be resolved before the project could be described as completed."

2. Project Status

Various opinions exist as to whether the MFTF-B project is either an active, completed, terminated, deferred, or mothballed project. Budget cuts are the reasons offered by some DOE project and program staff for considering MFTF-B either mothballed or deferred. Senior DOE officials and plasma physicists indicated that blaming budget cuts for the slowdown is a fiction.

The Office of Fusion Energy (OFE) has decided that an independent review of the project will be conducted in April 1986. The review will assess data from other mirror fusion projects including an experiment in Japan. The Japanese experiment does not share the problems of MFTF-B because of a different magnetic geometry. According to an OFE official, the data from the Japanese experiment may portend major retrofitting and an entirely new geometric design for the magnets before the project is completed.

DOE officials do not want to prejudge LLNL's ability to overcome the project's problems. They suggest, however, that caution is recommended because the reputation of OFE may hinge on the MFTF-B decision.

OFE officials stated there are several options available based upon the recommendations of the pending April project review panel. The options include turning on MFTF-B despite the existing problems. To many plasma physicists this could be a mistake, but they indicated project proponents, including the laboratory would apply strong pressure in Congress and in DOE to carry MFTF-B forward. To insure that Congress is accurately informed on the readiness of this facility, DOE advisors stated that there is a simple test that can be performed. This test would measure the central cell density at a prescribed power input level and will indicate the project's readiness. If the required measurements are not achieved, DOE officials and advisors stated that the project is not "completed" and Congress can anticipate that either major portions of MFTF-B's operations funding will be directed to correcting the problems or DOE will need additional line item appropriations to "upgrade" the facility.

B. Fusion Materials Irradiation Test Facility

Authorized in 1978, the Fusion Materials Irradiation Test Facility (FMIT) was designed to provide the focus for the materials development program. It was to provide materials irradiation data from an environment comparable to that in a fusion reactor.

FMIT had an original project cost of $138.5 million with $83 million representing construction. At the time of its 1979 review by the Under Secretary, this projection was deemed unrealistic and the cost estimate was raised to $168.4 million. Subsequent data shows funding to termination for FMIT was $94 million. Although the project was never constructed, technologies were developed which will be used in the development of the Strategic Defense Initiative and other R&D programs.

Assessments of FMIT project management were generally good, although there were references to management problems between the Hanford and Los Alamos national labs. The project was sited at Hanford but Los Alamos was responsible for FMIT's accelerator development.

An overwhelming majority of DOE officials agreed with the decision to terminate or defer FMIT. While DOE officials recognize that some type of materials testing facility will be needed before a fusion reactor can be built, most believe that need may be 70-80 years away.

The technology of materials testing will move ahead without a specific testing facility. Materials data will be available from the operation of existing experiments, both in this country and

abroad. Materials testing has often been suggested as a candidate for international cooperation. Early efforts to internationalize the FMIT project were unsuccessful, but it remains a scientific domain accessible to a cooperative effort.

C. An Improved Scenario for Project Management--Elmo Bumpy Torus

1. Project Development

In 1978 the Elmo Bumpy Torus (EBT-P) project was selected by DOE over several other theoretical project concepts. EBT-P represented an enlarged and upgraded version of an original device that had been in operation since 1973. It was described as a proof-of-principle experiment offering an alternative to other fusion approaches.

Initiated in the climate of growing budgets, EBT-P sought to demonstrate fusion viability in an alternate confinement scheme. Another aspect of this project was that it sought industry participation. DOE wanted industry to have an opportunity to break into the fusion program. Four teams, representing various combinations of corporate enterprises, including aerospace industries, architectural engineering firms, etc., submitted proposals to DOE for the EBT-P contract.

The process of competition between industrial partnerships in tandem with scientific workshops as part of DOE's contractor selection process has been lauded because it represented such a progressive approach to industry participation in a DOE development program. When contrasted with DOE efforts to secure industrial participation in projects such as GCEP and CRBR, the EBT-P method was praised as a worthwhile effort.

2. Project Management and Termination

Project cost moved from its first baseline of $86 million in January 1980, to a final total project cost of $145 million. A DOE official explained that costing out a project like EBT-P is virtually impossible. He said these projects are like "moving targets" and that it is difficult to put a price on technological developments.

Construction of this project was delayed until design data could be verified on another machine. This decision proved to be prudent because diagnostic measurements on this machine raised significant questions about the scientific merit of EBT-P's proposed design. An analysis of this data supported a decision to terminate the project. Although EBT-P was never built, a DOE official indicated total project expenditures approximated $30 million exclusive of close-out costs.

D. Future Prospects

1. The Magnetic Fusion Program Plan

The Magnetic Fusion Program Plan issued in February 1985 is witness to the fact that the proposed competition between fusion concepts, and the prescription of a fusion reactor by the year 2000 were specious goals. The plan suggests that in the post year 2000 era, assessments of fusion's viability will be made. Unlike the 1970's, when materials testing and reactor systems engineering were planned and funded in parallel with basic plasma physics R&D, the new plan, as explained by officials, makes facilitization dependent upon basic plasma physics R&D. The viability of fusion has yet to be demonstrated and recent experiments suggest that very basic thresholds of science are not yet understood. The science may not be as mature as lab officials would have Congress and others believe. Recent experiments have cast more doubts about our predictive understanding of plasma.

Some DOE research scientists caution that the present funding levels may not result in an organized basic research effort. The labs, suggested an industry representative, may only do R&D for R&D sake, and that the concentration will be on "playing with the technology, not demonstrating it." Officials in OFE indicated that, to avoid these problems, they have developed matrices to indicate where each experiment fits into the puzzle of understanding plasma physics.

2. The International Option/
The $400 Million a Year Question

OFE officials indicated that international cooperation is now considered a key ingredient for fusion's long term future. Since the viability of fusion is still a matter of debate, and since some suggest fusion will not be ready for commercial deployment until the middle of the next century, sharing development costs may be appropriate. In any case, Congress must decide if, given the state of the science, it intends to continue to fund this program at a rate of $400 million per year for the next 70-80 years. A senior DOE official indicated that without international cooperation the $400 million figure may be low because present budget outlays will not be sufficient to meet program demands.

VIII. THE ISABELLE PROJECT

A. Project Development

The birth of the Isabelle accelerator, a Brookhaven National Laboratory (BNL) project, occurred in 1977, when the third Woods Hole Accelerator Panel recommended the project. Initially, the research and development on Isabelle was considered to be immature, particularly relating to the first-of-a-kind magnets used in the accelerator. Later, however, the Panel believed that by the time Isabelle was funded, the research should be well in hand.

Isabelle was designed to collide protons with one another. Its mission, according to the January 1982 Secretary's Annual Report to Congress, was to:

> "* * * extend our knowledge of the fundamental structure of matter and energy and interrelationships of the four fundamental forces in nature."

Site clearing for Isabelle began in January 1979, and construction of the tunnel and other facilities proceeded very smoothly. However, the project experienced early problems with the state-of-the-art superconducting magnets. BNL had been misled by its initial successes with a prototype braided magnet into believing this design was suitable for the accelerator. Magnet problems persisted until early 1980, when a BNL scientist developed a new magnet design (the Palmer magnet). The magnet was tested in July 1981, and exceeded the design specification. At the end of 1981, the Palmer design was adopted, and the laboratory initiated an 18-month period of R&D in an effort to reduce magnet cost. By this time, Isabelle had fallen about 3 years behind schedule. This delay, combined with an unanticipated high inflation rate, created large cost overruns. The overrun estimates ranged from approximately $100 million to $400 million.

B. Project Management

1. Brookhaven National Laboratory

Isabelle became a "generic name" for failure in the scientific community. DOE officials generally acknowledge that although the physical bricks and mortar work on the Isabelle project proceeded very smoothly, there were significant delays attributable to the aforementioned problems with the superconducting magnets. It is believed BNL management made a severe error in technical judgment by not considering an alternate magnet design. According to critics, BNL refused to concede that the braided magnets were not suitable for Isabelle and that a new direction must be pursued. One former DOE official stated that BNL management was told on several occasions to consider alternate

designs, but management declined to do this. It feared changes at this stage might result in the demise of Isabelle. There is good reason to believe that BNL management acted in good faith rather than a negligent manner by not heeding DOE's advice. The laboratory believed it was very close to a solution for the problem. Furthermore, BNL was heeding the opinions of several technical review panels.

A contributing factor to the management problem at BNL was its university-type tenure system, which makes it more difficult to hire and fire personnel. It was suggested this system could auger future problems for BNL project management.

2. Department of Energy

Some of the responsibility for Isabelle's problems may be attributed to the "micro-management" behavior of DOE headquarters. When the problems with Isabelle's magnets became more pronounced, DOE's management posture became more aggressive. DOE solicited monthly reports of such technical nature that it required key laboratory personnel to take time away from their normal duties to prepare them. DOE was also requesting the removal of the Isabelle project manager. BNL management fought with DOE headquarters over these issues.

BNL management is somewhat exonerated of responsibilities for problems with Isabelle by a November 1979 Energy Research Advisory Board report. According to the report, DOE was attempting to fit the Isabelle project into a standardized management scheme which was inappropriate for a project such as Isabelle with its "highly technical personnel." In this regard the report concluded:

> "* * * that Isabelle should not be forced to fit the proposed standard DOE format for program management and that, if this is attempted, serious consequences may result for both the project and for DOE. To avoid this, we suggest adherence to the format which originated with the AEC which allowed major decisions to be made by the Brookhaven Laboratory."

The report also noted that DOE had inserted strong "non-technical" management between the headquarters program office and BNL in the form of the Chicago Operations Office. Additionally, there were further consequences in having excessive management from different offices in headquarters. Thus, BNL was receiving directions not only from the program office, but also the Director of Procurement, Director of Administration, and others. This headquarters confusion, combined with the intermediate responsibility of the Chicago Operations Office, was often the source of many conflicting directions to BNL.

C. Competition--The Reason for Project Termination

One of the signposts for the high energy physics community for the past 10 years has been the search for "w" and "z" particles. These were postulated, but previously unobserved, subatomic constituents of matter. Each new accelerator was hoped to be the first one to see these two particles and thus win a Nobel Prize for the discoverer. Isabelle was certainly no exception to this premise. In fact, it was stated this search was one of the prime reasons for the conception of Isabelle, and at the time it was believed Isabelle would be the only accelerator capable of providing the opportunity to see these particles.

When Isabelle ran into delays with the superconducting magnets, CERN, a European competitor for Isabelle, made some technological breakthroughs including the development of a new method of cooling. Isabelle's delay permitted CERN to take a shortcut to develop the new cooling technology; CERN might not have taken this risk if Isabelle had remained on schedule. In any case, the race for particle discoveries was over. CERN discovered the "w" and "z" particles, and two Nobel Prizes were awarded to the discoverers.

CERN proved the particles could be observed more easily than anticipated, and the U.S. program had another accelerator facility, Tevatron, which was under construction and would also be able to study these particles in detail. Thus, the high energy physics community was faced with a choice; complete Tevatron for $60 million or complete Isabelle for $400 million and at a much later date than Tevatron. According to one physicist this was an easy choice to make--the tough part was explaining to Congress why Isabelle was no longer wanted.

D. Project Termination

The FY 1983 Congressional budget request contained no funds explicitly for Isabelle. In the fall of 1982, BNL began looking at alternate design concepts for Isabelle in the event that funding would not allow construction in the present configuration. Work came to a standstill in 1983 due to the lack of funds and in mid-1983 it was concluded that all the interesting physics had passed by. Furthermore, with the Europeans moving continuously ahead and a linear collider under construction at Stanford, there was no purpose for building this accelerator. Shortly thereafter the Isabelle project was officially terminated because of "technical reasons having to do with the magnets." Another factor which is believed to have directly affected the fate of Isabelle was that the High Energy Physics Advisory Panel lost interest in Isabelle and wanted to save money for a new more powerful machine, the Superconducting Super Collider (SSC). It was believed the United States had lost its world leadership position in high energy physics and that the success of a project like the SSC could permit the United States to return to a preeminent position.

One former DOE official said, "The high energy physics people were, in unambiguous terms, promised the SSC by an administration official if Isabelle was killed."

The credibility of the high energy physics community has been severely impaired as a result of Isabelle's termination. This action earned the high energy physics community a reputation for indecisiveness. Many members of that community expressed regret for their Isabelle decision and believe the effort to make BNL the "scapegoat" for project cancellation was unsuccessful and it was, in fact, the reputation of the high energy physics community, not BNL, which has suffered the most. Also, they believe the promise of SSC grows dimmer with time. It was noted that if Isabelle had been completed, it would have been ready for experimentation before 1990. SSC may not materialize before the year 2000, if at all.

E. Future Prospects--The Superconducting Super Collider

1. Project Justification

According to many physicists, SSC is the next logical step in accelerator evolution. This machine, said to be a "scientific imperative," will be a prodigious undertaking for the high energy physics community. In 1983, the project was deemed to be technically feasible by the High Energy Physics Advisory Panel, which further stated that SSC was essential in order to insure a strong U.S. high energy physics program in the 21st century.

The SSC is an accelerator which will collide counter revolving beams of protons at energies up to 40 TeV (trillion electron volts). Like Isabelle, the SSC will use superconducting magnets and is expected to take about 6 years to build. The SSC currently envisioned will be 75 miles in circumference and almost 24 miles in diameter. Physicists hope to have the project on line by 1994. Preconstruction research and development was first funded in FY 1984, and is expected to take 3 years to complete. This preliminary funding amounts to $20 million annually. According to one laboratory official, the current research is aimed at cost reductions because it is believed the SSC technology is well in hand, but the cost is not. Most researchers believe the SSC, if it is built, will be the last of its kind.

2. Project Variables

An association has been established from four research groups to coordinate preliminary SSC technology development and identification of site requirements. The siting and cost of SSC

are its two most significant issues. Various individuals have stated the SSC will cost $2-$8 billion, or more. There was concern the SSC could bankrupt other scientific disciplines by siphoning away their funds. The SSC would not only cost a lot of money, it could deprive the United States of knowledge in other scientific areas. Most people believe, because of its price tag, SSC should be placed into a special funding category outside of DOE's high energy physics budget. Furthermore, the SSC, due to its cost, would not be solely a DOE management decision, but would also have to be reviewed by the President.

Another variable which must be factored into the cost equation is the subsequent operating costs of the SSC. It was pointed out the annual operating cost of an accelerator facility is generally equal to its average annual construction cost. For example, using a construction cost of $4 billion over a 6-year period, implies the SSC will cost over $600 million a year to operate. The large operating cost is the result of the need for costly detectors and other technical equipment.

3. Project Advocacy

The high energy physics community is already actively campaigning to obtain support for the SSC in political circles and with other scientific disciplines. Contrary to what is typically being reported by the scientists, DOE senior management is not currently considering the SSC as a potential construction project. The schedule and plans (discussed above) for the SSC represent the intentions of the high energy physics community because as of now, DOE has not taken a position concerning construction of the SSC. Indications were that DOE will probably give the SSC some thought next year, but this could be more in relation to postponement rather than a go ahead. A DOE official stated that a major consideration for the SSC is the deficit, and that "any major budget cuts could very well delay the SSC until the 21st century."

4. Project Competition

Potentially SSC is another entry in the race between the United States and Europe in the area of high energy physics research. The current entries in this race include the Stanford Linear Collider and a new European accelerator at CERN. Both projects are designed to study essentially the same regions of nuclear forces. However, Stanford Linear Collider is touted to be a "* * * major step toward reducing the cost of future very high energy colliding beam devices, * * *." Construction on the European project began in early 1982, and it is expected to be completed in early 1989 at a cost of approximately $500 million. The Stanford Linear Collider was started in late 1983, and is expected to be finished 2 years ahead of and at one-fifth the cost of its competitor. Barring any unforeseen difficulties, the project may beat Europe to any important discoveries and revenge earlier losses incurred by Isabelle. In this seemingly neverending

competition, DOE science advisors suggested that if the Stanford Linear Collider is successful in this effort, Europe/CERN will respond to the challenge and modify its accelerators to beat the SSC. According to former DOE officials, the high energy physics program could get approval for SSC only to have it, like Isabelle, become scientifically obsolete before it is completed.

5. The International Option

The competition for discoveries and Nobel Prizes has become so intense U.S. physicists indicated some agreements or proposals for international cooperation are essential before SSC is approved. The threat of a European effort to beat the SSC was considered very real, and cast doubts about the economic viability of the $6-8 billion proposal.

International collaboration is not without historical precedence. The United States is currently building one of the detectors for CERN's new accelerator, and with several other countries is in the process of building an accelerator in West Germany. Each country is supplying components for the device, but no country is providing direct monetary funding.

International collaboration for SSC has been discussed. In fact, according to one laboratory official, Italy has offered $1 billion towards the project. Additionally, DOE officials have held meetings with Japanese officials, and it is expected Japan will offer up to one-half of the necessary superconducting magnets in exchange for certain user rights.

* * * * *

Would any of you like to comment on that now, or would you prefer to just answer for the record.

Yes, Doctor?

RESPONSE TO INVESTIGATIVE REPORT

Dr. TRIVELPIECE. As I said, it is to some extent no particular fault of the individuals who made the decisions at the time. The problem has always been can you sustain and maintain support over a long period. I think that these kinds of technical programs are best served by stability and continuity, and that the roller coaster effect indeed produces worse efforts than not spending any money at all to begin with, because exactly the kinds of thing you cite occur.

How to determine what constitutes a sustainable level of support for these things and what their priority should be within those levels, I think is the question. I suppose that the Administration and the Congress should probably work together to try to define what constitutes those reasonable levels. It isn't something where I think anyone has acted in bad faith on this. It is that the circumstances changed and we need to adjust to them, but there is a lesson to be learned in them, and that is to try to establish a basis for proceeding in a continuous way that is agreeable to both parties, House and Senate and the Administration.

Miss FITZPATRICK. Mr. Chairman, I don't think it is possible to minimize the difficulty that faces anyone who tries to make decisions aimed over a long term planning. The premises change, the facts change, the world changes, and we are embarked on projects that take many years to complete, and involve the investment of large amounts of money.

Can I offer some reassurances to you that a number of the projects that were begun some years ago at the height of the energy crisis have been brought to completion and are showing very successful results?

For example, the solar central receiver project is operating very well.

The Heber binary geothermal plant, to which the Department contributed about $60 million, is operating, was dedicated in December of 1985, and is operating well.

We are completing this year our large wind turbine program with the Mod-0 and Mod-2 experiments and this is being brought to its planned completion.

Even the Mod-5, which we have proposed not actually building, has given us a great deal of information in the design phase, and I think that that stands ready and available for industry when we find that they would like to build large wind turbines, which at the moment they apparently don't want to do.

While it is frustrating, I think on the margin there probably are decisions that we wish now perhaps hadn't been made now that we have the benefit of 20-20 hindsight. But, I don't think by any means it has been a total loss. I think we have made extremely good progress. We have trained people; we have learned things that we didn't know five or ten years ago; and I think we are much better off for having pursued that course.

Mr. BEVILL. Congressman Akaka wanted me to meet with his friends from Japan this morning, and I did meet with them momentarily on the proposal of a joint effort between Japan and the United States. I was impressed with what they said about it. I am impressed with what you have said about it, but should we ever start any more new programs at the rate we are going?

Miss FITZPATRICK. I would hope to be able to continue to pursue promising opportunities, and I think that international collaboration is something that we must pursue, simply because it is quite clear that we don't have the resources to do some of these things, as Dr. Trivelpiece was referring to international collaboration on fusion, and also because the more we work with our allies, the more concerted effort we can make to understand what the real energy problem is.

It is an international problem. It is not just a U.S. problem.

Mr. BEVILL. Would you recommend that we be more cautious in starting new programs in the future as a result of our experience here in the last five or six years?

Miss FITZPATRICK. I think that we should take a very careful look at anything that requires the large expenditure of funds, based on premises which we now know were not so easy to have confidence in. We have learned that it isn't easy to predict energy costs or even supply availability, and I think that we ought to be careful that we are making those decisions based on information which is as good as we can get, and allowing for the inevitable margin of error.

Mr. BEVILL. You three play a very important role in our energy program in this country. Are you all going to be very cautious before you come in here and recommend any new starts, new programs?

Miss FITZPATRICK. I don't think we have very much choice to do otherwise.

HIGH PRIORITY ENVIRONMENTAL AND SAFETY ISSUES

Mr. BEVILL. Secretary Walker, why is the Department of Energy now placing such a high priority on environmental and safety issues? What events have caused this?

Ms. WALKER. Mr. Chairman, I think it is a combination of factors. It is a growing regulatory and statutory——

Mr. BEVILL. Concern?

Ms. WALKER. There are a lot of additional requirements that the Department has to meet, coupled with what the Secretary has described as "a legacy of the past", in terms of environmental problems and issues concerning complex manufacturing and scientific facilities. It is mirrored in the private sector, and I think that it is a recognition that dollars are going to be short, that we want to be the wisest decision makers we can be, and the only way to be wise decision makers is to know what is on the plate, to be able to prioritize them intelligently, so that when we do come before Congress, we are coming forward with those items which need to be taken care of first. We really do want to be as environmental as well as safety, of course, but environmentally good citizens, so that we can demonstrate both to the public and to Congress that our record of

performance is excellent, and that we can be trusted to manage our own shop to ensure that we will accomplish our mission consistent with environmental and safety considerations.

Mr. BEVILL. You have just been on the job two months?

Ms. WALKER. I was sworn in this January, sir.

Mr. BEVILL. You are doing, I think, mighty well. Our good friend, the ranking minority member of the subcommittee, Mr. John Myers, is at a funeral today, but we have another member here that can equally fill those shoes. I recognize Mrs. Virginia Smith.

ALCOHOL FUELS

Mrs. SMITH. Thank you, Mr. Chairman.

Welcome to all of you. We appreciate your presentations.

I would like to start my questioning on the ethanol fuel. Given the declining price of conventional energy, what is the future of renewable energy, particularly ethanol, in our country?

Miss FITZPATRICK. I think, Mrs. Smith, that at this moment the ethanol industry is facing a really dire fall in prices. As you know, the product price for ethanol in the United States is about $1.50 to $1.60 a gallon. Right now I understand that the market price in the Midwest is running at $1.35 to $1.40, which means that they are losing money.

They are saved from going completely out of business by the fact that there are still available both federal and state tax credits, or rather exemptions from excise taxes on automotive fuel using alcohol. However, with oil prices continuing to fall, the direct competition between gasoline and ethanol is going to be weighted against ethanol. That means that the industry is in a rather precarious state, and unless oil prices go up again, they will continue to be in that state.

Mrs. SMITH. Miss. Fitzpatrick, in what ways is your Department encouraging research to reduce production costs of ethanol?

Miss FITZPATRICK. We are encouraging research and, in fact, are active in research, which would increase the conversion efficiencies of feedstock to ethanol. Also, we are looking for feedstocks that would be more plentiful and cheaper, because the major cost in ethanol, of course, is the feedstock.

Mrs. SMITH. Would you explain why the Department has scaled back its research funds from $29 million to $2 million? Do you feel that you have reached your goal?

Miss FITZPATRICK. No, we don't think we have reached our goal. We have, however, been able to eliminate some of the possibilities that we have been exploring, and focus our work on the more promising possibilities.

Mrs. SMITH. Would you give us for the record a report on how this $12.2 million that you have requested would be divided between various biofuel projects, including ethanol and methanol?

Miss FITZPATRICK. Certainly, Mrs. Smith.

[The information follows:]

Biofuels 1987 budget

Activity	*Amount*
Aquatics	$1,300
Short rotation intensive culture	2,500

Activity	Amount
Herbaceous energy corps	1,400
Biochemical conversion [1]	3,100
Thermochemical conversion	3,300
Capital equipment	600
Total	12,200

[1] Alcohol fuels R&D is included in this activity.

Mrs. SMITH. Now, what is the status of the alcohol fuels project today?

Miss FITZPATRICK. You are referring to the loan program?

Mrs. SMITH. Yes.

Miss FITZPATRICK. The Secretary's authority under the loan program has been extended by Congress until June of this year. We have under active consideration three applicants for loan guarantees.

Mrs. SMITH. Is one of them Blair, Nebraska?

Miss FITZPATRICK. Yes, it is.

Mrs. SMITH. My next question was going to be what is the status of the Blair, Nebraska project? Is all you can tell me that it is still under consideration?

Miss FITZPATRICK. It is still under consideration. We are working very hard and actively with the applicants to help them satisfy the conditions which they must meet. They have to get together their construction and financing, and many legal documents, and again, they are faced with the spectre of falling fuel prices, which means that their economic considerations must be under constant review by them and by us. But we are working very actively with them.

HYDROPOWER

Mrs. SMITH. I have just one more question, and that is in regard to the small scale hydropower program. I see you request no further funds for it. Would you tell me what has been accomplished, and why you think the program is no longer needed?

Miss FITZPATRICK. That program has been in operation for several years, and has very successfully assisted in the installation of small scale hydropower projects throughout the country. In the last couple of years, we have been basically completing monitoring project results. We think that since we are no longer actually putting money into projects and have not more time, we think that it is now time that that monitoring, the remaining monitoring that has to be done, can pretty much be handled by people who are basically covered by other agencies.

Mrs. SMITH. Thank you very much.

I have no more questions.

Mr. BEVILL. This entire committee is very interested in gasohol. Mrs. Smith especially.

Miss FITZPATRICK. It is an old technology, Mr. Chairman.

Mr. BEVILL. The Chair recognizes Mrs. Boggs.

Mrs. BOGGS. Speaking of that, Mr. Chairman—but first I would like to greet all of you and thank you for your fine testimony, and for your answers.

I shouldn't say this, Dr. Trivelpiece, but it is sort of nice to see you outnumbered at the table.

Dr. TRIVELPIECE. Thank you.

GASOHOL

Mrs. BOGGS. Just following through on Mrs. Smith's questions, doesn't the boost in octane that gasohol provides give it a marketability that it otherwise may not have?

Miss FITZPATRICK. Yes, Mrs. Boggs, it does, and that is something that the marketers of ethanol and gasohol are going to be paying more attention to, I would suspect. Actually they have been using alcohol not so much as an octane enhancer, but as a gasoline extender, which meant that ethanol was competing against the price of simply more unleaded gasoline. Especially with the phaseout of lead in gasoline, I think ethanol probably will be a little bit more attractive as an octane enhancer.

Mrs. BOGGS. And that consideration of course, Secretary Walker, impacts upon the environmental qualities as well, so apparently we have made the decision that we are not going to have leaded gas. It would seem to me that it is an added incentive to the alcohol fuels producers.

Miss FITZPATRICK. Yes.

Mrs. BOGGS. To boost the octane component of their advertising and their thrust.

COOPERATIVE RESEARCH AND DEVELOPMENT VENTURES

Secretary Fitzpatrick, I am very interested in what seems to be new efficiencies to further our cooperative research and development ventures with productive industry consortia, which will include university type consortia, working with private industry. I visited one such facility in Georgia not long ago, and I think it is a very exciting development.

If we will be able to increase the technology transfer by involving industry earlier in the R&D sequence, in some of the programs that we have undertaken, would they now be perhaps operational, and there would be no need to cut out the continued development of them at the government level.

Miss FITZPATRICK. I think, Mrs. Boggs, you are correct. That early involvement of industry is the key to both successful research and successful technology transfer, and wherever that might not have been done as effectively as possible, we would in the long run suffer the lack of successful pickup by industry.

Our policy has been for several years to include industry from the earliest phase of planning of our R&D, and to include them in the R&D itself through cost sharing projects, and also to include universities which generally are not capable of cost sharing. We would like to look at the cooperative ventures that you mentioned as another tool to enhance these efforts.

We think that certainly the more that industry is involved, the more that it is putting its own resources in, then the greater vested interest it has to continue with the work and to use the results and also the great experience that their own people have in what is being achieved.

ENVIRONMENT AUDIT AND COMPLIANCE

Mrs. BOGGS. I notice, Secretary Walker, that you are going to have an environmental audit. You have a section on environmental audit and compliance activities. If the industry is involved at an earlier stage, would it make it easier for you to evaluate the environmental aspects of the way that industry is implementing the development of the various uses of energy?

Ms. WALKER. We do evaluate early in the process any project or anything that the department undertakes through the National Environmental Policy Act, the environmental concerns and weight those in decision making. And, of course in any new efforts, we are incorporating environmental requirements along with whatever design or facility is being built.

The Office of Environmental Audit and Compliance is really dealing with ongoing compliance issues at the Department of Energy facilities, and specifically dealing with our field organization structure, which has to comply not only with federal regulations and requirements, but often with state and local entities as well, that may have particular, in fact more stringent requirements. They attempt to provide a department-wide consistency in policies and its application, so that what we are doing, we are doing consistently as well as correctly.

NUCLEAR PAYLOAD LAUNCH ACCIDENT

Mrs. BOGGS. The department is currently involved in research on the use of nuclear reactors to power satellites, and these reactors would use fissionable materials such as plutonium. Have you evaluated what would happen, should an accident occur during a launch of one of these satellites, such as the tragedy that occurred in January?

Ms. WALKER. We are currently engaged in participating both through an interagency group and also through our Department, and through my own organization, in various safety analyses of projects that are planned or on the table, and we are projecting probabilities for all sorts of scenarios, including accidents.

I don't know that there is a specific one that I can refer to at this time, but if there is additional information I could provide it for the record. We participate especially with nuclear power space vehicles. We are particularly looking at the accident potential.

Mrs. BOGGS. Would the destruction of a satellite powered by a nuclear reactor during its launch pose a threat to the environment?

Ms. WALKER. I believe it certainly could, and whenever we talk about a launch scenario, with a vessel that has nuclear or radioactive substances aboard, yes, we are very involved in terms of safety. I mean, if we are involved in that project we are very concerned about that potential, and we look at it from all angles. That is why special casing and special design features are included, so that that possibility is eliminated or reduced.

Mrs. BOGGS. How serious would the threat be to the launch site, if such an accident occurs?

Ms. WALKER. I couldn't give you specific figures. I would have to call upon one of my folks that are either here with me or we could

supply that for the record. It obviously depends on the particular design of the vehicle. Each one may have separate design components which would have different probabilities involved with them. It would depend on the particular phase that we are talking about and it would depend on the strength of the explosion. As I indicated I don't have the specific information, but could provide it for you.

Mrs. BOGGS. I would like very much if you could provide as much information as is available for us for the record.

Ms. WALKER. I would be happy to.

[The information follows:]

ENVIRONMENTAL IMPACT OF A NUCLEAR PAYLOAD LAUNCH ACCIDENT

We are currently reviewing the environmental and safety aspects of the next two nuclear power spacecrafts (Ulysses and Galileo). These two spacecrafts would use radioisotope thermoelectric generators (RTG) fueled with plutonium-238 as its heat source. The two missions are planned to be launched from the Space Shuttle. This would be the first time an RTG was launched from this type of vehicle. This review is in progress and we need to look at a number of factors including those associated with the Challenger accident before we can draw any conclusions on the environmental impact for these two missions.

However, there have been 21 launches involving RTGs, and I will discuss the two largest inventories that were launched, Voyager and the Lincoln Laboratory Experimental Satellites.

For the Voyager Project, the NASA Final Environmental Impact Statement concluded that the probability of radioactive fuel being released due to a launch pad abort was less than one chance in a million. If any fuel were released, only a small fraction would be respirable. It was concluded that it was unlikely that anyone could receive a radiation dose that would exceed the established dose limit for the general public. The total plutonium inventory for Voyager was 239,100 curies.

For the Lincoln Laboratory Experimental Satellites (LES 8/9), analysis showed that the total probability of any plutonium release was about 2 in 10,000, with release of 30 millicuries inhalable plutonium dioxide or less accounting for the bulk of this probability. The total probability for releasing more than one curie of respirable plutonium would be about 2 in 10,000. The risk of releasing plutonium was shown to be much smaller than the risks of fatalities from many other natural and man-caused natural events. It was concluded that it was unlikely that anyone could receive a radiation dose that would exceed the established dose limit for the general public. The total plutonium inventory for the LES 8/9 launch was 318,800 curies.

FUSION

Mrs. BOGGS. Dr. Trivelpiece, please discuss the next step in the U.S. fusion research, particularly the proposal for the compact Tokamak.

Dr. TRIVELPIECE. As I remarked in my opening statement, fusion has reached the point where it is now possible to design a device which can create, confine and heat a plasma to generate the conditions where fusion reaction can take place. That is a very important milestone, and this year, 1986, should see the TFTR device at Princeton perform that particular event.

The next step beyond that, however, is to create a device in which one of the fusion products—alpha particles—that carry some of the energy in the release of the reaction are not lost. So there needs to be a new experiment done in which it is possible to contain that energy in such a way that instead of just keeping the sustained burning going by delivering energy into it and taking the

energy that comes out of it, you would like it to be a self-sustained reaction. That term is referred to as an ignition.

In other words, to accomplish that, something is needed which has either slightly higher magnetic fields or slightly larger volume, or both, and that device is referred to as an ignition device. It is the next scientific step that the program requires. It will probably cost somewhere in the neighborhood of $300 million at a minimum in order to do that.

However, that is not the ultimate step. The ultimate step is the one I was referring to earlier as an engineering test reactor. That probably costs, it is estimated now, in excess of $3 billion, and it would be one in which it would be operated more as a user facility, in which it would produce neutrons from fusion reactions, and would permit investigation of various engineering steps that need to be accomplished before you could make a practical reactor.

The compact devices are devices which follow a slightly different line, that is, as I said, you could make the device with a slightly larger magnetic field or slightly larger in physical volume.

There also is another approach that some individuals have been proposing, which is to make the volume smaller, but makes the magnetic field substantially larger. This follows another engineering path which confronts one of the other limitations. One limitation is that as you start making it big and things get better as you make it bigger, eventually you reach a size in which it is just no longer effective.

You could go in the other direction, and increase the magnetic field strength, which moves along one of the other parameter lines, but that confronts another technological limit. That is that magnetic fields exert force, and the structures required to contain those forces have certain limitations, and you can only go so far in that direction.

We are trying to pursue this in both lines. One of them is in effect an alternate to the main line. The main line is to make the devices slightly physically larger than they are now. The other is to pursue the stronger magnetic field. However, the main effort is going towards the physically larger rather than the stronger magnetic field, but some work is continuing along the lines of stronger magnetic fields.

INTERNATIONAL FUSION RESEARCH

Mrs. BOGGS. Could you discuss the plans for international fusion research, what types of contributions other countries are proposing?

Dr. TRIVELPIECE. There are a number of activities that have gone on for some time. Fusion programs could probably be characterized as already heavily involved in international collaboration. We have had arrangements with the Japanese and others for some time. The Japanese have contributed something in excess of $70 million toward the operation of some of the apparatus that goes into the Doublet experiment at General Atomic.

Probably a total contribution of things that come to the United States from other countries is about $100 million. Ironically the United States has not sent much money overseas. In that sense we

have not been a good bilateral partner. We have contributed very little. The activities like the large coil test, do benefit other countries, because there we built a facility at the Oak Ridge National Laboratory in which there are very large super-conducting coils that have been supplied by U.S. venders. Then there are other coils that go into this test facility, one of which is supplied by Japan. The other two have been supplied by European countries, and so they benefit by the knowledge that will be derived from it and they obviously have put money in, in the form of the cost of the coils that they have supplied, but they haven't put any money into the operating costs directly.

We have not put, as I said, much money in these activities overseas. As I said earlier, we have reached an international consensus that the next major step is a device which probably costs about $3 billion. As a result of my activities in dealing through the economic summit process in the last few years, there is a recognition that this ETR is probably the next major step. The question is should three or four countries simultaneously build the same object to get the same result at the same time at a cost of $3 billion each? That is ridiculous, and shouldn't occur.

We have been looking into the possibility of dividing that by two, three, four, and of course, dividing it by four has been given some credibility by the Reagan Geneva summit meeting in which the President specifically mentioned fusion there.

There have been meetings then with the summit working group, the economic summit working group subsequent to that, to look into these possibilities of what makes the next steps I guess is the right way to say it.

Mrs. BOGGS. Excuse me, Doctor, is this Japan, Europe, USA, USSR?

Dr. TRIVELPIECE. Yes, those represent the four major entities, and for practical purposes they are approximately equivalent in their present level of knowledge in the field and level of effort. It is too soon to say yet exactly what will be the outcome of all this. We have been meeting regularly through a National Security Council working group to discuss what the United States position is going to be, and some of those activities are still in the process of being decided.

Some of the things we might do are still in the process of being decided. We will probably meet with Soviet representatives in the near future to discuss what their views are on this. It is a desirable thing to do. It is clear that the time has come in which it needs to be done in a full partnership multilateral basis for some of these next steps.

It is easy to say you should go do international collaboration, but it is not until you have actually sat down across the negotiating table with a group of six to ten people from as many countries, that you find it turns out to be very difficult. We are trying to do it, and I think we are making reasonable progress actually, toward what we all would regard as a desirable end state.

QUALITY OF SOVIET RESEARCH

Mrs. BOGGS. Is the quality of the research that we receive from the Soviets in exchange for information developed by our scientists of high quality?

Dr. TRIVELPIECE. In my view it is. This is a debatable subject, but certainly we are currently exploring a device in the United States as the principal line of research for the United States program which is called the Tokamak. That is a Russian word which means magnetic chamber in effect, so we have received something from them of a practical nature.

There are many contributions that they have made and there are some contributions that we have made to them. I think on balance, it has been a fair exchange in the fusion program. There are some areas, of course, in which there is concern about information transferred to the Soviet Union that might be put to military purposes, but in my opinion, that has not occurred in the fusion program.

Mrs. BOGGS. Do you feel the CIT project, as it relates to the international research plans currently under discussion is going very well?

Dr. TRIVELPIECE. Yes.

Mrs. BOGGS. Thank you so much.

Thank you, Mr. Chairman.

Mr. BEVILL. The chair recognizes Mr. Fazio.

MFTF–B SHUTDOWN

Mr. FAZIO. Thank you, Mr. Chairman.

I realize we have covered fusion to a great extent, Dr. Trivelpiece, but I simply wanted to ascertain my strong views that to mothball this machine at this point certainly doesn't make much sense from almost any standpoint that I can relate to. You are going to give the committee the figures as I understand it, that would permit the machine to be used, to have experiments and operate during the next fiscal year, one that you claim will exceed a $20 million figure, is that correct?

I had heard some implication that for slightly more than what you are talking about spending to shut it down, we could begin the process of using the machine. I guess that is a debatable issue, and you are going to try to provide the committee with data, is that correct?

Dr. TRIVELPIECE. Yes.

INTERNATIONAL FUSION RESEARCH

Mr. FAZIO. Mrs. Boggs was asking questions about the international role here, and I encourage you to move in that direction. I don't have any problem with the thrust of your efforts, except that I wonder how we can be promoting fusion, internationally and certainly in the context of our summit talks, and at the same time withdrawing from our own program. Is that going to be in some ways a mixed signal to the other countries that are participating with us?

Dr. TRIVELPIECE. I would be less than candid if I didn't say it was inconvenient. On the other hand, the discussions that led to the statement by Mr. Reagan and Mr. Gorbachev were occurring down one channel and the activities that led to the $50 million reduction were occurring down another chanel.

Mr. FAZIO. As is so often the case.

Dr. TRIVELPIECE. And they both went to completion. The requirements for near term funding for any kind of an activity that might grow out of the summit suggestions is clearly very small. The earliest possible time that you might conceivably begin to see increases in budgets, if there were to be international collaboration on a major facility, would be in the early nineties, so it isn't something that is going to impact this year's or next year's budget. I think we can do the necessary planning within the budget envelope we are now working under.

Mr. FAZIO. You are not predicting a fusion delta here in the interim in the latter years of the eighties while we build up again to a national fusion program, or are you doing that? Are you suggesting we have seen the halcyon days of fusion for the time being?

Dr. TRIVELPIECE. Making forecasts is a dangerous business for oil prices or for fusion budgets. I am somewhat reluctant to make any fearless forecasts at this time, but I think that the general plan is at about a level budget for the foreseeable future, at least as far as the Administration has been concerned.

Mr. FAZIO. A lower level budget?

Dr. TRIVELPIECE. At about the level of the President's request, yes.

SUPERCONDUCTING SUPER-COLLIDER

Mr. FAZIO. I wondered if I could ask you to comment on the two track system as it related to the decision not to proceed on the collider. Is that appropriate to ask today do you think? We had a reference in the state of the Union address and at the same time we don't see any OMB followthrough. Is there again the left hand not knowing what the right hand is doing in the Administration as it relates to some of these major initiatives that we try to excite public in?

Dr. TRIVELPIECE. I am not sure I understand the thrust of your question.

Mr. FAZIO. As I understand it, there isn't any specific funding to complete the process of deciding on the feasibility of the super-collider and at the same time, of course, we alluded to it in the state of the Union address, and in other places where we want to sound positive and futuristic. Where does the rubber hit the road here? Are we serious or aren't we?

Dr. TRIVELPIECE. In my view, it would be desirable to have gone one more year at about the same level in the high energy physics program with respect to that part which was developing information to help us decide on whether or not to proceed with the SSC. The Gramm-Rudman consequences have had an influence here as well.

We have two new facilities which are coming on line, the Tevatron I and the Stanford linear collider. Both of those have caused

operating demands to be placed on the limited funds within which we have to operate. I thought it would have been irresponsible to short change the operation of those facilities to keep some of the research going that would be needed to make a decision on the SSC. To use this perhaps obscure idea, it perhaps being unspecified, but with the understanding that this year we will present a series of briefings to the Secretary on the science, technology, the cost, feasibility and schedules and so on of the SSC, with the idea of trying to come to a go-no-go decision this year.

That is, it is without prejudice. He has not said that he is either going to or not going to but has an open mind, and is waiting until we present the information to him, and then he will either be persuaded that he would like to proceed, in which case I am sure he would have to discuss this with the President. But it is not——

Mr. FAZIO. He told the committee he had to make a decision to either go or not go.

Dr. TRIVELPIECE. Yes, and we are trying to get that information available, and this is happening a year earlier than I would have otherwise liked to see it, but I think we are being pushed into that earlier decision by Gramm-Rudman, and it doesn't necessarily mean that if the decision is no in '88, that it is no forever. It could at sometime in the future——

Mr. FAZIO. Do you think the SSC will become an internationally shared project the way we are pushing our fusion program?

Dr. TRIVELPIECE. I am sure that it will. I am quite confident. I just last week was in Japan and met with one of the leaders of the Japanese high energy physics program, and he was explaining to me that they had a committee meeting and that the outcome of that was that they had decided that if they were going to join with anything they would join with the SSC. That doesn't put any money in the bank but until we have something to lay on the table to discuss with them in concrete terms, it is kind of in the abstract, but at the abstract level, I think that is about as strong a situation as we could possibly manage.

Mr. FAZIO. Just as one individual who is a strong supporter of moving forward in this area, I think that makes a lot of sense. I think the sooner we own up to the fact that we don't seem to think we have the resources to do this sort of cutting edge scientific work, particularly in this magnitude, on our own any more, the sooner we get to a point where we begin to realize that we have to cooperate with other developed nations that have scientific capability—and I think the longer we delay that, the longer we will fall back from the challenges of the frontiers of higher energy physics.

GRAMM-RUDMAN IMPACT

I would simply like to say though that this constant reference to Gramm-Rudman is becoming like a mantra, and it isn't really appropriate. Gramm-Rudman is sort of what the rest of the government is getting. The Department of Energy in its non-nuclear weapons program has had a form of Gramm-Rudman imposed on it by OMB for a long time now—five years. I don't think we are solving the budget deficit problems of the Federal Government by further restricting the kind of scientific research that we are being

asked to do in the Department of Energy by the product community. I think we simply have decided that it isn't important relative to other things, including the deficit reduction, but other things in addition to the deficit reduction as well, and I really think it would be fair to say that the Department of Energy budget isn't faring very well at OMB these days, and I think that is what is up.

We are finding solutions to our budget deficit problems by adding $31 billion to defense, and by refusing to consider revenues, and of course, I don't see that as making a major contribution. Let me just put my silent protests out here—not quite as silent as some would like—but a protest out on the record. I don't really blame you, because I know you are doing the best you can with a limited amount of resources, trying to balance a lot of Hobson's choices. I think any way you go you are probably going to be criticized.

Dr. TRIVELPIECE. I have noticed that.

Mr. FAZIO. You are doing a pretty good job of standing up to it all, too.

RENEWABLE ENERGY

I would like to talk about renewables, because I don't think they have been touched on as frequently as some of the other issues. I guess I am very troubled by the continuing reductions in support for renewables. It is sort of highlighted by a breakfast that Mr. Bevill and I had this morning with some people from Japan, who want to know whether the Department is going to spend $500,000 that we appropriated for OTEC research. I think Miss Fitzpatrick Donna is going to meet with some of these people this afternoon.

They don't seem to be thrown off the track of energy independence in Japan simply because of declining oil prices. They are wondering whether they can count on us as a partner of some bearing. They don't think we are following through on commitments that we have made, and this gets us to the issue of deferrals, rescissions and all of the constitutional issues involved in that. But essentially they are either saying just the kind of thing the private sector says to us here. What kind of a steady, long term partner are you? You get us hooked on a program as a contractor or as a cost share partner, and then all of a sudden, without any warning, or without any formal warning certainly, you turn off the spigot in the middle of the project or at the point where the project is about to be completed.

MOD–5 MACHINE

I guess maybe I can do something I rarely do, use graphics. Here we have the Mod-5 machine over in Hawaii. Hawaiian Electric has shown us some of the work that is being done, and some of you—I know Bob has probably seen this and some others—since it will cost $12 million under the contract we have to tear it down. It would cost us $15 million to proceed, and to see some sort of benefit derived out of this. It is a $3 million savings to the government if we terminate this program essentially as a result of these contractual obligations we have.

Are we going to spend $12 million to tear it down here? I guess I am trying to find the picture. This is probably the best way to show

it, to end up with a savings of $3 million for nothing, no feedback, no data, no successes in what is obviously going to continue to be for other nations in the world an area of scientific inquiry, with a commercialization component that will really contribute to another suggestion of ways to reach energy independence. I would be happy to show this to my colleagues if they want to look at some of this data.

Donna, do you have any feel as to why we are taking this kind of step at a time like this? Don't use Gramm-Rudman?

Miss FITZPATRICK. I will try to avoid that. I think the $12 million disassembly figure is a new one to me.

Mr. FAZIO. Apparently it is in the contract. The attorneys who represent the Boeing Company and Hawaiian Electric will be happy to show you the situation.

Miss FITZPATRICK. I am sure our attorneys will have something else to say. I would like to look into that figure though. We think that we have learned a great deal from the Mod-5 project. We have a design and it is a shame that we don't have resources available, in our judgment, in the priorities that we have developed to continue with the building and operation of the Mod-5. It is simply a matter of trying to get the best that we can out of our resources. We have learned a great deal about large wind turbines both from the design of Mod-5 and also from the operation of Mod-2 and Mod-0 machines.

Mr. FAZIO. Don't you think we need to know about the operation of Mod-5?

Miss FITZPATRICK. Someday we probably will. Our problem right now is that we have other demands being placed on our budget, things that probably nobody can do except the Federal Government, and the industry has not shown an interest at this time in continuing with large wind turbines. They are very interested in the 100 to 1,000 kilowatt size turbines, and we are continuing with our efforts there on design and aerodynamic and structural stress studies, and that seems to be what will be most useful to the industry at the present time.

Mr. FAZIO. I understand the industry has been increasing their share. I mean, they are getting the message about cost sharing.

Miss FITZPATRICK. Yes, they are.

Mr. FAZIO. It has been drum beaten into them, and I think this is a good example of where we have gotten increasing participation from the utilities and from the manufacturers who really do want to at least demonstrate that the technology has commercial use. I would think that maybe you are trying to get their attention for even more. I don't know, but it seems to me that we are being penny wise and pound foolish in not finishing some of the things that we have almost gotten to the point of completion. Bob is trying to make a point.

Miss FITZPATRICK. He is encouraging me to note that we certainly would be receptive to substantial cost sharing.

Mr. FAZIO. In other words, if they will finish the project, you certainly won't totally pull away, is that correct?

Miss FITZPATRICK. Of course.

HAWAIIAN CABLE

Mr. FAZIO. I find that to be a good case study of some of the problems, but I think we have to look at a number of others. What about the Hawaiian cable venture? I will just let you talk for a minute. How do you justify what we are doing there?

Miss FITZPATRICK. The Hawaiian cable contract is about to expire. We are negating an extension of it at this time. We have sufficient carryover funds we think to carry it well into 1987. We have completed the design of the cable. We have completed, with the State of Hawaii, the analysis of the topography of the ocean floor and the channel between the islands. We have completed the design of the cable-laying equipment and the cable-laying vessel. We are building the cable itself, a sufficient amount for laboratory tests, and we think that we are making good progress on that project.

Mr. FAZIO. We would like to see that contract extended into '87, because again, we think the program would be in effect killed, terminated, if we don't.

Miss FITZPATRICK. No.

Mr. FAZIO. I think there is a real requirement that we finish what we started.

Miss FITZPATRICK. We have, Mr. Fazio, no plans, we have made no decision to kill that. What we need to do is to complete the present work that is scheduled under the funds that are available, which will bring us to a point of deciding what is the next best step, and if we decide to go on with it, which would certainly be beneficial to the State of Hawaii and also to the cable industry, then we would request funds for '88, which I think would be in good time to continue this without interruption.

Mr. FAZIO. In '88 we will have that unmentionable law behind us, is that it?

Miss FITZPATRICK. I am not so sanguine, Mr. Fazio.

Mr. FAZIO. I am not either. I hope you are going to come and tell us what you need. I am not fixated on Hawaii, but I think in these areas both the cable issue and development under Mod-5, we would be finding this committee very supportive if we kept going to the finish line, and not dropped out of the race, throwing in effect the opportunity to foreign competition, because as I said in regard to the OTEC issue, there seems to be no flagging in their efforts to continue to develop a marketplace that they know eventually will be there, perhaps in much bigger numbers than may appear today in the context of $15 a barrel oil.

ELECTRIC ENERGY STORAGE

Let me ask you also about the electric energy storage budget. This committee showed a good deal of interest in the cost shared continuation of the zinc-bromine battery program, but you have deferred those funds. In 1987 you don't propose to finish that program. You are beginning to make decisions I gather—I think prematurely—about what sort of storage battery will be chosen to go forward, and even that to a rather uncertain fate. Would you comment on that?

Miss FITZPATRICK. You are correct that we are doing some focusing on that program, and we have seen the most promising battery as the sodium-sulphur. We have funds for continuing work this year on the zinc-bromine battery. We have run into issues that need to be resolved before those funds made available in '86, before all of them could be used.

Mr. FAZIO. So you are not terminating that program?

Miss FITZPATRICK. No.

Mr. FAZIO. You haven't proposed a rescission in lieu of deferral?

Miss FITZPATRICK. No, we haven't.

Mr. FAZIO. In so many cases you should but haven't, but you think we may not have heard the end of that.

Miss FITZPATRICK. If the zinc-bromine——

Mr. FAZIO. There is some sort of hope, is that what you are saying?

Miss FITZPATRICK. Yes.

Mr. FAZIO. What do you expect us to see?

Miss FITZPATRICK. There are a couple of issues that have cropped up that need to be resolved before we can continue areas of development on zinc-bromine. One is the deposition problem. The battery tends to short itself out and we need to solve that before we can continue with the rest of the projects.

Mr. FAZIO. I am sure you will be keeping the committee apprized of the progress that we are making. I am sure the people involved in that will be working very closely with you to satisfy you.

DEFERRALS

We touched on the question of deferrals. Particularly I think it has been used in the areas as I indicated—I think you were here the other day when Secretary Herrington was testifying that relative to renewables and to congressional add-ons. Would you want to comment again? We just can't imagine why all congressional add-ons seem to be almost to the penny deferred, and in some cases those deferrals as we all understand, amount to killing programs.

We think that is an obvious abuse of executive authority, but isn't there anything that we come up with that makes any sense to the Department of Energy? I know that is a tough question.

Miss FITZPATRICK. I certainly thank you for the opportunity.

Mr. BEVILL. You may want this answered for the record.

Mr. FAZIO. I would like to have this on the record, Mr. Chairman, I really would.

Miss FITZPATRICK. Sometimes it isn't true that what is being deferred is simply killing a program.

Mr. FAZIO. Sometimes.

Miss FITZPATRICK. Yes, very often.

Mr. FAZIO. It should never be, of course.

Miss FITZPATRICK. No.

Mr. FAZIO. But sometimes it is.

Miss FITZPATRICK. Sometimes it is, that is true, and sometimes what has happened is that it has been an add-on to what was already an Administration request for funds. What happens is that we are being consistent in our recommendations, and when we are asked to——

Mr. FAZIO. Some would say stubborn.

Miss FITZPATRICK. Stubborn, yes. That can be done, too.

Mr. FAZIO. You are brooking no conflict. The legislative process, the Appropriations Committee, and the other part of the federal budget process are being ignored essentially. I mean, if you cut solar from $144 to $72, and we add back $8 or $9, you can't accept that as some sort of balancing of priorities. I mean, that could well be the case this year. This committee isn't throwing money at you to do renewables in solar. You are just not accepting any of it. That is what we have to glean from the deferrals and rescissions of 1986.

What else can we conclude from this? I like to think there is still some support in Congress, and I believe there may even still be some in the bowels of the Department of Energy for some of these initiatives. I think we can cite the photovoltaic project that Secretary Herrington mentioned the other day. People seem to like to be around to take some of the kudos. I don't blame them. The department did a good job managing that program, but why do you have to be dragged kicking and screaming to do it? Sometimes the screams weren't that loud. I could hear you whispering those screams, Bob.

Miss FITZPATRICK. All I can say, Mr. Fazio, is, as you noted, we have strictures and we are asked to come up with our best recommendations within certain levels, and we try to do that.

COST SHARING PROPOSALS

Mr. FAZIO. I think the budget documents you submitted refer in general terms to a method of technology transfer which is of great interest to some of my colleagues, particularly Mr. Watkins, in which DOE would request industries to cost share joint research projects. The intent is to go in the direction of what we hesitate to call commercialization, knowing that is not part of the market strategy in every case, but we think this is in a period when these are pre-competitive energy initiatives, when they need to be given some assistance to show the marketplace that they can pick them up and carry on, even a marketplace that is not so heavily biased by tax policies and current energy prices, I think, and we think we have got some proposals coming along that furthers that.

But given the fact that that is the philosophy expressed in your budget, are you at all interested in looking at some of the cost sharing that the Electrical Power Research Institute is proposing for further development of photovoltaics?

Miss FITZPATRICK. Yes, I am.

Mr. FAZIO. I am wondering what you see for the private nonprofit sector at this point. What kind of role do you want them to provide, and what do you think those limited constrained DOE dollars ought to go for? In very specific terms, take photovoltaics. For the record if you could show us——

Miss FITZPATRICK. I would like to comment on the record. I can say that the institutions such as EPRI, I think, have played an extremely important role which has dovetailed very effectively with what the Department has been trying to do. We have been trying to have programs applied at the basic research spectrum. EPRI, for example, tends to pick up on the latest applied research moving

into product development and demonstration phases, which I think has been a very helpful role for them to play. We do continue to work with them and I would be very happy, especially in photovoltaics, to hear their proposals and expect to continue to work with them.

Mr. FAZIO. What role do you think the Department has? You obviously don't expect them to replace the work that we do. Why do we need to be involved at all is perhaps a better way to put it. What unique contribution can we make?

Miss FITZPATRICK. I think that there are still very basic issues, especially in materials and semiconductors, which are at very early stages of investigation, which are still high risk, which still require equipment and trained people that we have and that industry doesn't have, and probably could not justify because it is so far away from commercialization, and I think we still have an extremely important role to play in that.

Mr. FAZIO What other technologies would you see as being important for future development in renewables?

GEOTHERMAL

Miss FITZPATRICK. I think geothermal holds tremendous promise, and we have made significant contributions to that field. Several of the things that we have been successful with are now moving into the commercial industry and will be used there. A couple of examples would be the down hole packer, which has been very successfully tested in the hot dry rock project. We have also made great progress in solving the problem of scaling in the wells for the solids coming out of solution on the pipes.

I think we are making progress in biofuels, great progress in solar thermal technologies, particularly in building better collectors and heliostats.

Mr. FAZIO. The Federal Department of Energy budget has been allocated in these areas and bears some of the credits for these breakthroughs that you cite?

Miss FITZPATRICK. Yes. I mentioned things that have come out of the federally funded research programs.

Mr. FAZIO. I like to hear people taking credit for the work we do. I just wish we would do more.

Miss FITZPATRICK. I sometimes get a little irked because I don't think that the Federal Government gets sufficient credit for what we do. I often read magazine articles about things that we did and nobody mentions that it was federal tax dollars that accomplished that.

Mr. FAZIO. I totally concur with your premise. I think we can get together and agree on a number of issues, because I think our research in some cases has been absolutely essential at getting the partnerships together that have borne some fruit. I would like to do it more often.

Miss FITZPATRICK. I would, too.

Mr. FAZIO. Do you think we will both be around long enough?

Miss FITZPATRICK. I don't know. My grandmother is 84 years old.

Mr. FAZIO. My grandfather lived until he was 92.

Miss FITZPATRICK. We have a good shot at it then.

Mr. FAZIO. I think we may have to do it in some other way of accomplishing our general purpose.

DEFERRALS

I think at this point I will put a number of questions in some great detail in the record, but I would like to give some assurances—I am sure the chairman would—to these visitors that you will be seeing from Japan. When do you think the department is going to make up their minds about this deferral on the $500,000? Are we going to be a good partner or are we going to drop the ball on OTEC?

Miss FITZPATRICK. I think that deferral has been submitted and I don't know that it is under any reconsideration, so I think it is up to Congress.

Mr. FAZIO. It is up to us?

Miss FITZPATRICK. Yes.

Mr. FAZIO.So much of what you submit is up to us, and I really appreciate all the support that these projects get from the department, if the Congress wants to add the money back. That is always the line we get. We send our friends over to see you. We love the program, we think it is great. If the Congress puts the money in we will certainly support it. Then we end up busting the budget over here, for reasons that we all understand are absolutely logical, essential, and from anybody's standpoint, business, government, whatever, cost efficient.

It is awfully frustrating, but I understand your frustrations, too, and I look forward to working in those areas where we have some common purpose and perhaps some budgetary wiggle room, and I appreciate any response you can give to these questions in great depth.

Thank you, Mr. Chairman.

Mr. BEVILL. Very good.

Secretary Fitzpatrick, do you anticipate any deferrals being called back?

Miss FITZPATRICK. No, I don't at the moment, Mr. Chairman.

Mr. BEVILL. The chair recognizes Mr. Boner.

Mr. BONER. Thank you, Mr. Chairman.

SUPERCONDUCTING SUPER COLLIDER

Dr. Trivelpiece, I want to ask you about the Oak Ridge project. Going back to fusion just a moment, how realistic are the figures that you have presented to us as they relate to the super-conducting magnetic test facility, and the advanced facility?

Dr. TRIVELPIECE. How realistic are they? I believe them to be good estimates. I don't know that there is any deficiency in them.

Mr. BONER. You feel that the figures that you have there can accomplish what you want to have accomplished?

Dr. TRIVELPIECE. Yes sir.

ENERGY INDEPENDENCE

Mr. BONER. As general proposition, do you agree or do you not agree, that while we may be enjoying an oil glut, it is a good idea

to take advantage of this slowdown and move ahead toward energy independence and not wait for another crisis to take place?

Dr. TRIVELPIECE. That is a very interesting philosophical question, and of course the United States as a country seems to have a habit of operating best under moments of crisis, and responding, and certainly the oil embargo of '73 produced such a crisis and we did respond rather dramatically at that point.

When the pressure to perform seems to abate, we seem to relax. We seem to be in a slightly more relaxed mood with respect to some of these problems evolving at the moment, but there is no doubt in my mind but what the energy problem is still out there. The energy consumption of developing countries is likely to increase. The United States energy consumption is certainly going to increase, and it is geared in some way to the economic activity.

It will re-emerge. Exactly when and in what manner I think is subject to a great deal of debate, and then that gets weighed against contemporary requirements for budget control and so on. There is no easy way to answer the question, but I am convinced the energy problem has not gone away. It is just simply dormant for the time being.

Mr. BONER. I agree with you. We seem to be a nation of reaction more than a nation of action, and if that is the given, is it not important that we invest adequate funds now in programs like fusion to move us toward a desired independence, rather than waiting until we have another oil scare to have to go to that direction again?

FUSION BUDGET LEVEL

Dr. TRIVELPIECE. You are getting at the origin of the issue, and that is what constitutes an adequate level of support for the fusion program. In the present deficit climate, we have proposed a budget level that is the Administration's proposal that we think is consistent with that.

The rate at which fusion or other energy technologies are made available is in many cases fund dependent. There are people who know what to do and how to do it and are eager to do it, but you have to weigh that against the price of money and borrowings the Federal Government has to make and what that does to the long term deficit problem.

There is no easy answer. These are not simple technical questions. These are combined political, philosophical and technical matters that require adjustment on the part of a large number of individuals, and the Congress is clearly one of the important players in this.

Mr. BONER. Mr. Chairman, I certainly believe it would be wise to spend more money than is proposed in the fusion program, and I think that the future may show us that it would be.

ENVIRONMENTAL ACTIVITIES AT OAK RIDGE

Secretary Walker, I know you are new on the job. Let me ask a couple of questions about our Oak Ridge operations in Tennessee. As you know, both the EPA and the State of Tennessee have been highly critical at times of the DOE's commitment to the environ-

mental quality in the past. I would be remiss if I didn't say I think Joe LaGrone has done a good job in meeting these sensitive problems head on. He might not have always responded to them like I would have wanted to, but nonetheless, he has done a good job.

What is the status of cleanup operations at the Oak Ridge Operations Office?

Ms. WALKER. There are several areas of concern that are currently being addressed by them, and I would highlight just three for you, ground water protection at Bear Creek and East Fork Poplar Creek; the uranium release and the mercury.

With respect to the ground water contamination, they currently have proposed projects to correct some of that and some studies are underway. Measures to reduce further contamination of groundwater include discontinuance of discharge of waste to the seepage ponds, improved surface drainage of landfill areas and modified land disposal methods. In addition, actually under Joe LaGrone's management, they are putting in place measures to reduce waste generated so that in the future we will have less waste to dispose of.

In terms of the mercury contamination, there is an interagency task force consisting of representatives from DOE, EPA, the State of Tennessee, the TVA, the U.S. Geological Survey, the Corps of Engineers, the city and the citizens group that are looking at a comprehensive study of mercury in the environment, and will be providing findings and recommendations concerning whatever remedial measures are appropriate for that.

For the uranium release to the atmosphere specifically with respect to the Y-12 plant we have a stack emission project to control the uranium emissions planned for FY 86 at a cost of about $30 million.

Mr. BONER. Am I correct in my assumption that the requested figure is the minimum level necessary to do that job?

Ms. WALKER. On the stack emission project sir? I am not aware of that. I would presume that it is, given fiscal constraints. We have pared down all of our environmental requests to make sure that we are at a level where we can do the job, but there is no extra in there at all.

Mr. BONER. Could you give me a brief update on the contract conditions that DOE has with Bechtel National for your formerly utilized sites for remedial action program?

Ms. WALKER. As I understand it, there has been an extension granted on the Bechtel contact for the participation in the program.

Mr. BONER. Thank you, Mr. Chairman.

Mr. Chairman, we are mothballing a lot of things. Secretary Walker, are you going to mothball the environment?

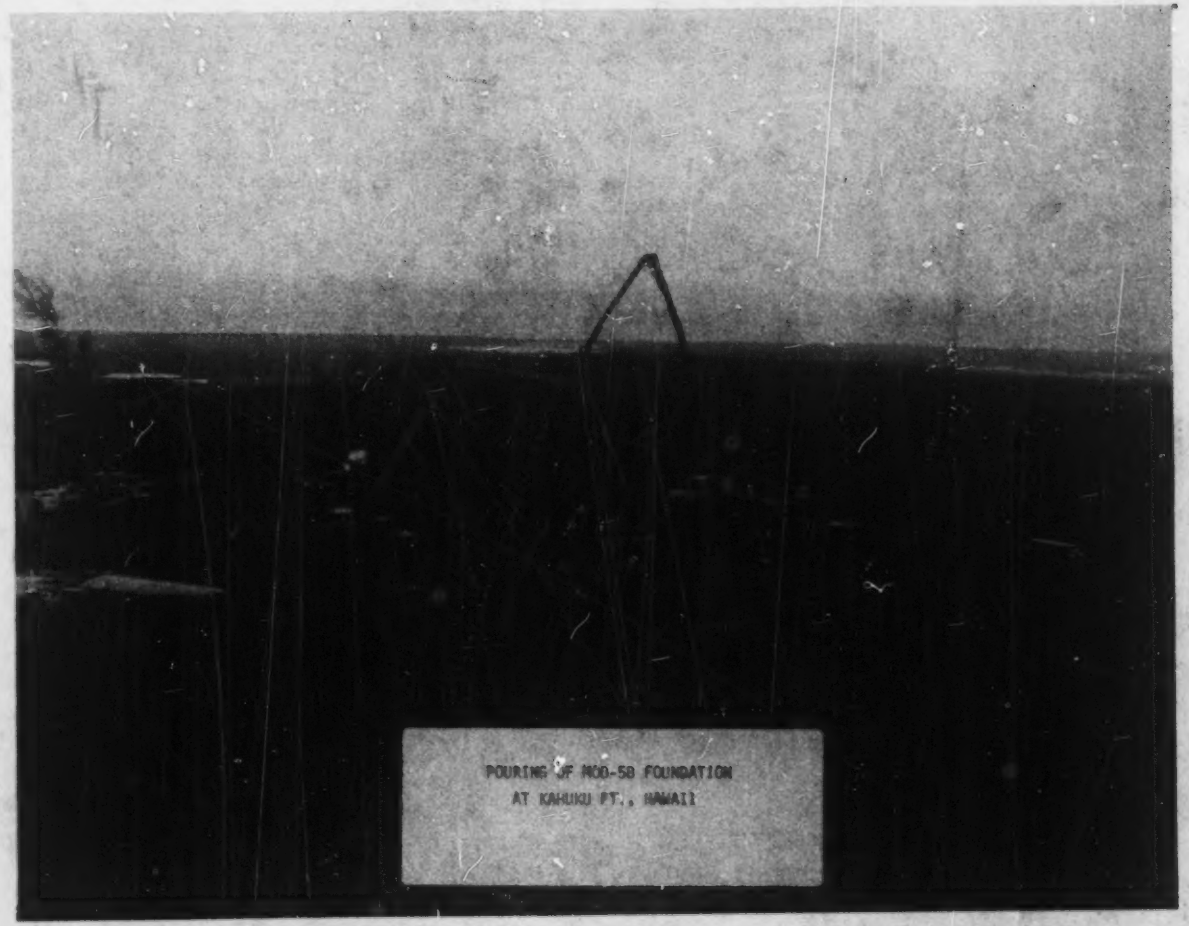
Ms. WALKER. Unfortunately, the environment is a growth business.

Mr. BEVILL. Mr. Fazio, would you like to have these pictures included in the record?

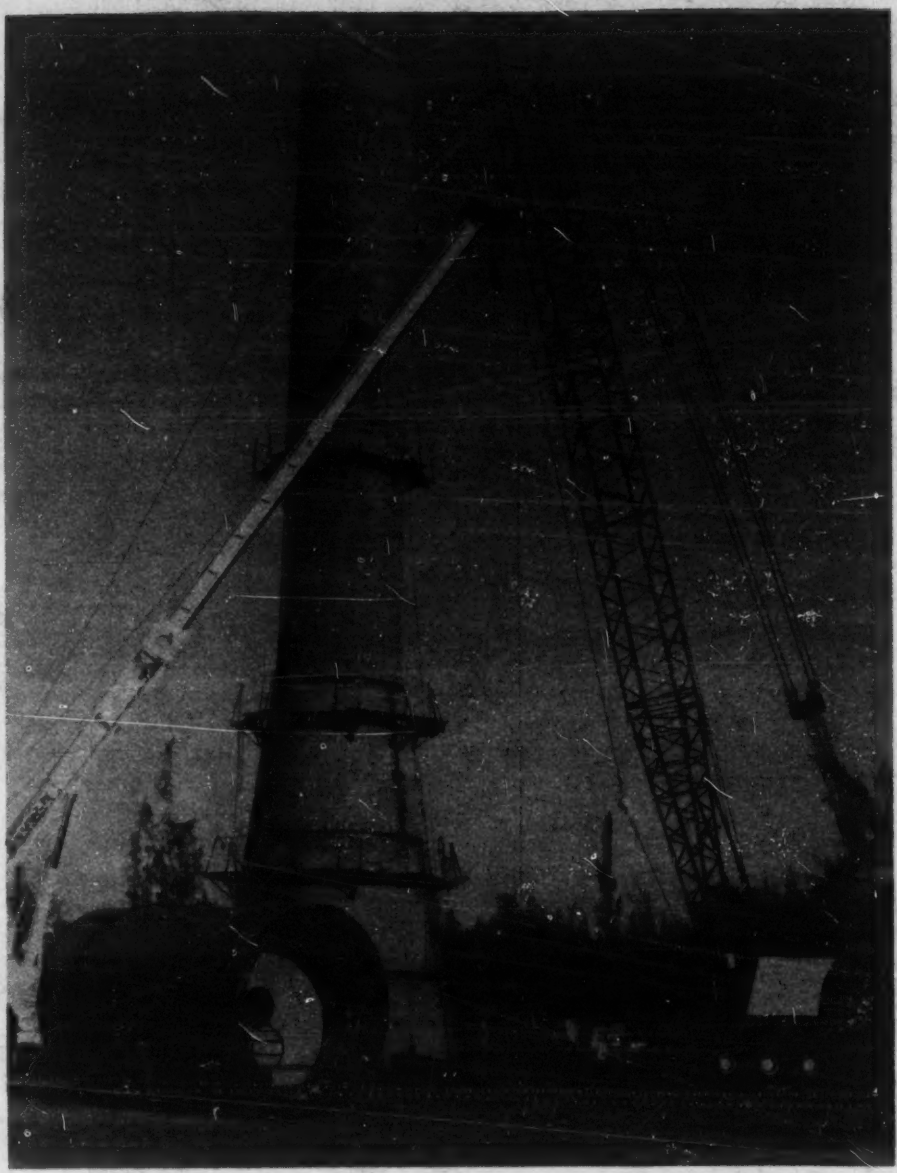
Mr. FAZIO. I would be more than happy to place those in the record.

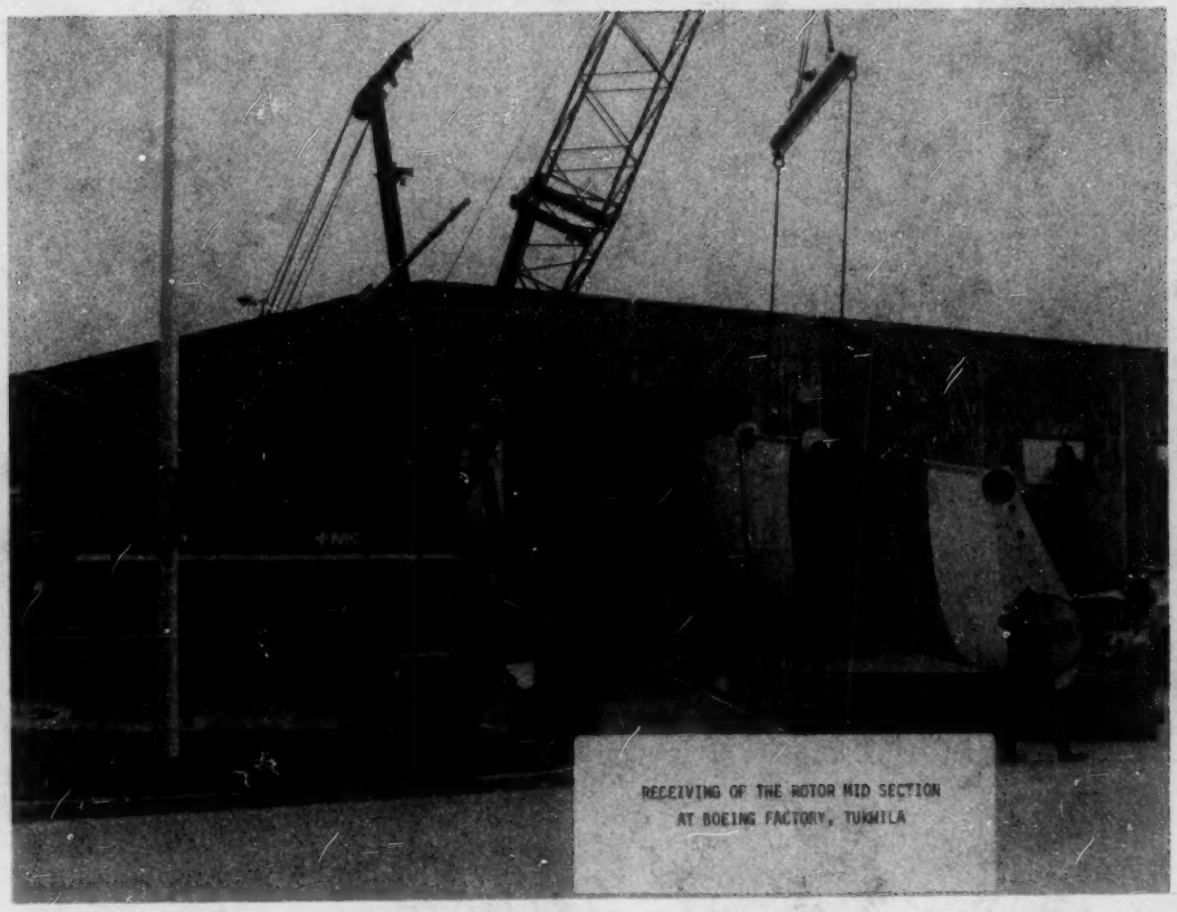
Mr. BEVILL. They really cover the story. They are good pictures. If there is no objection, we will put these photographs in the record.

[The photographs referred to follow:]

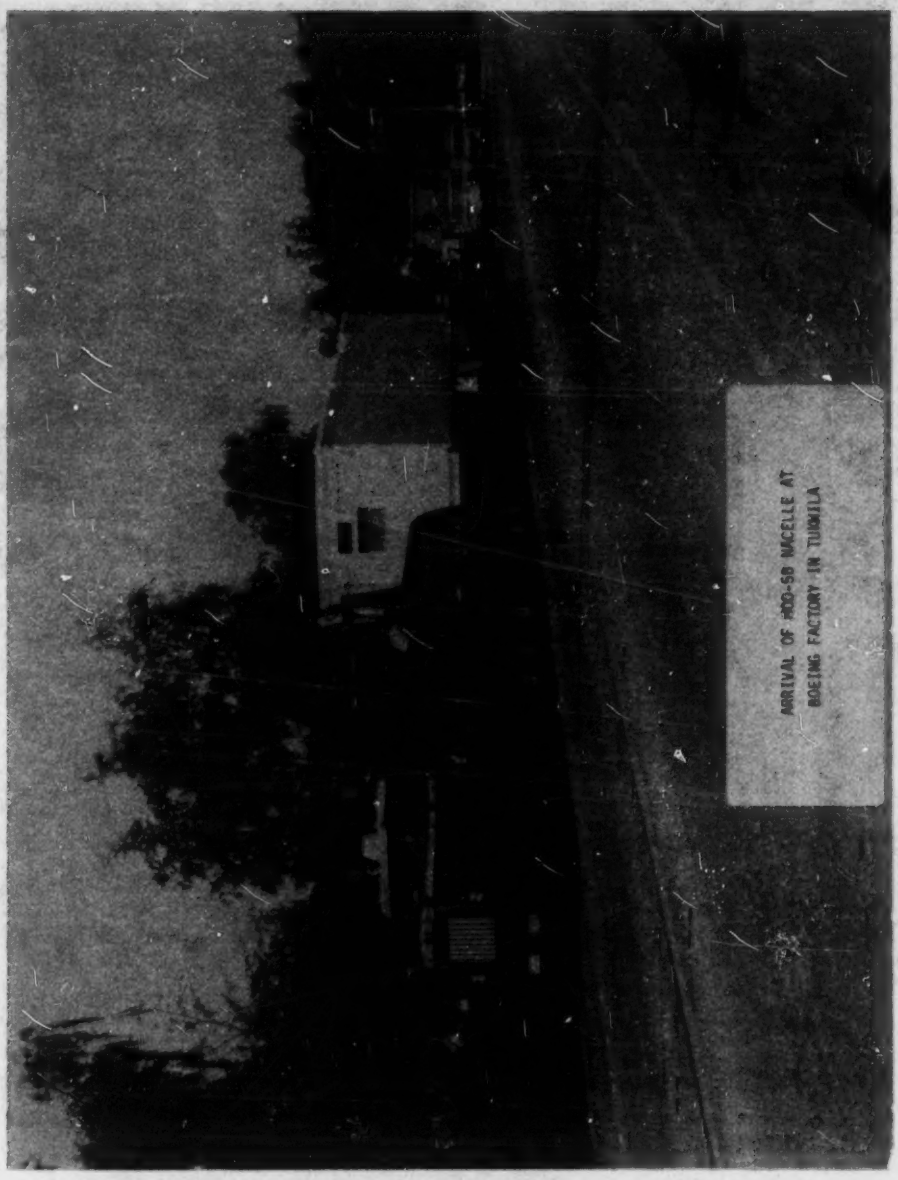


POURING OF MOD-5B FOUNDATION
AT KAHUKU PT., HAWAII

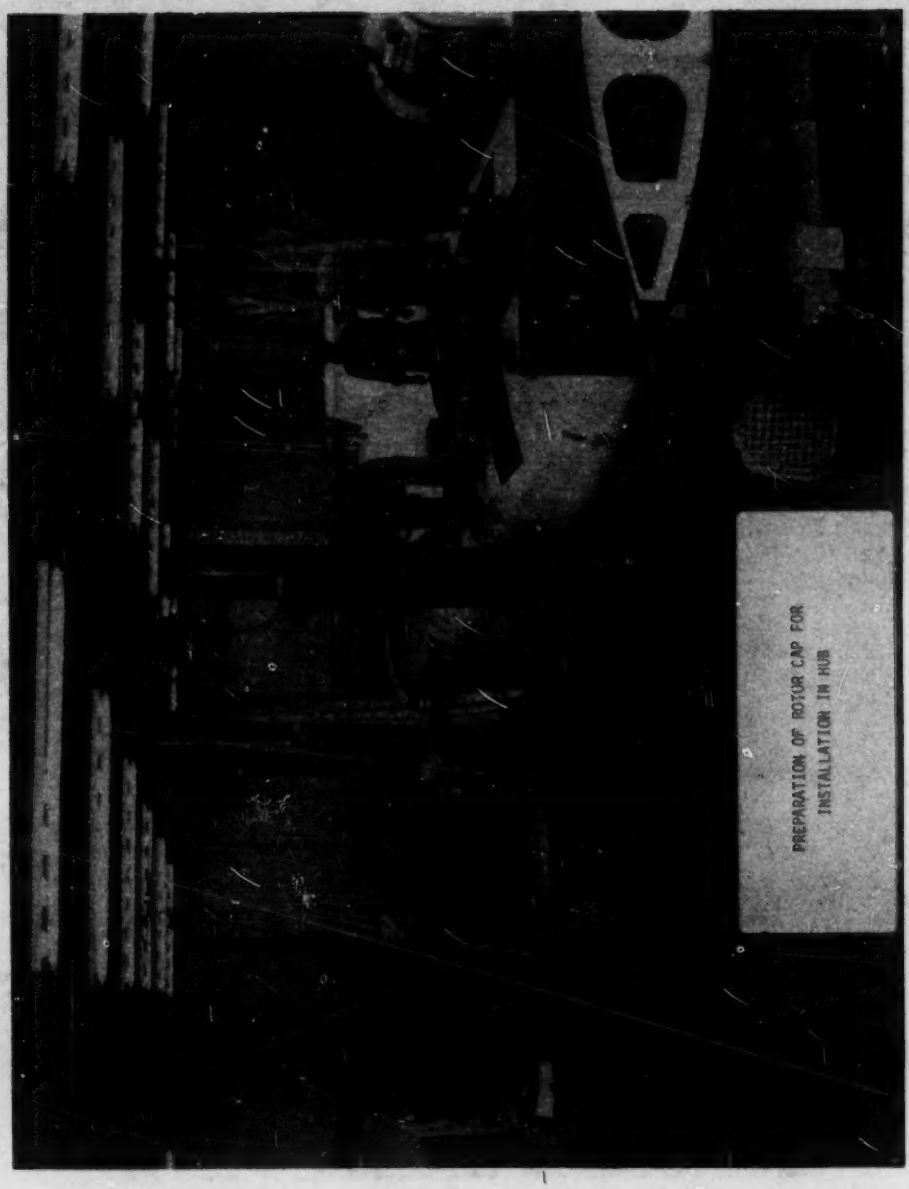


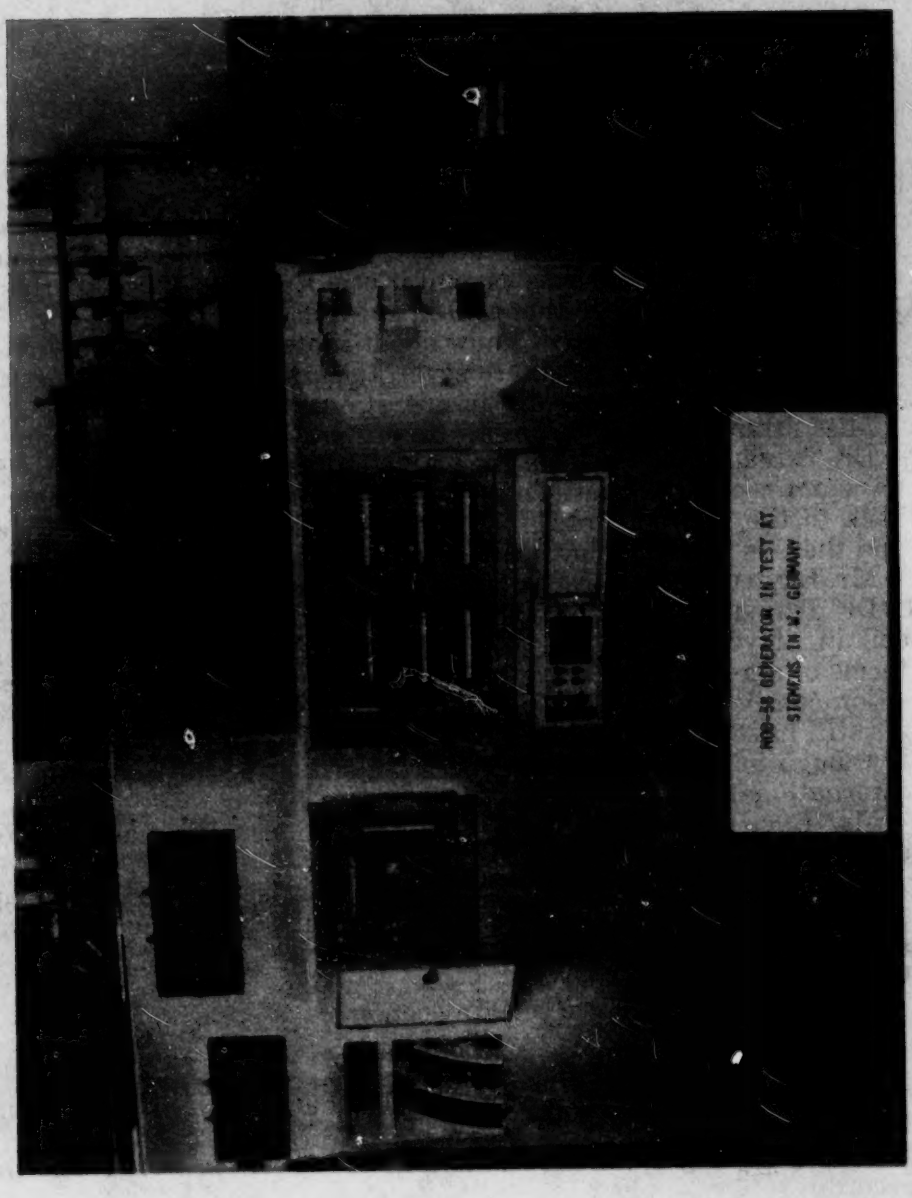


RECEIVING OF THE ROTOR MID SECTION
AT BOEING FACTORY, TUKWILA



ARRIVAL OF JT8D-5B NACELLE AT
BOEING FACTORY IN TUKWILA


PREPARATION OF ROTOR CAP FOR
INSTALLATION IN HUB


MOD-0A GENERATOR IN TEST AT
SIEMENS, IN W. GERMANY

Mr. FAZIO. I have some questions for Ms. Walker that I will also place in the record.

Mr. BEVILL. All right.

MHD PROJECT

Mr. BEVILL. I just have one question here.

Secretary Fitzpatrick, I am just curious to know, talking about these foreign projects that we have, is the MHD project just outside of Moscow there, I think as I recall it, the Russians call it the Institute of High Texture. Is that still in existence?

Miss FITZPATRICK. I don't know about that, Mr. Chairman.

Mr. BEVILL. I went out there several years ago and I was just curious to know if that was still in operation.

Miss FITZPATRICK. I am not aware of that, Mr. Chairman.

Dr. TRIVELPIECE. I believe the coil is still in the Soviet Union. We have not recovered that. There was a plan at one point to bring it back to the United States, but the last I heard it was still there, and there is no immediate plan to remove it.

Mr. BEVILL. The project is no longer underway?

Dr. TRIVELPIECE. I think the Russians are still maintaining the coil in, if you will pardon the expression, a mothballed state in terms of agreement that we have had with them, until some disposition can be made of either the coil or the program. But the Soviets still have an MHD program. They are not using that coil directly though in the experiment. There are still some difficulties in the international agreement with them.

Mr. BEVILL. Are there any other questions? We have several questions.

Secretary, Walker, we welcome you. This is your first time appearing before this committee. You certainly did a fine job. I was impressed when I noticed that you supervise 220 lawyers. I had trouble supervising two.

Ms. WALKER. There are certain economies of scale.

Mr. BEVILL. You did very well.

Ms. WALKER. Thank you.

Mr. BEVILL. This committee stands adjourned until 1:00 p.m. Monday.

[The following questions and answers were provided for the record:]

PROGRAM OVERVIEW--SOLAR AND RENEWABLES

Mr. Bevill. Madam Secretary, can you describe how the budget request for solar and renewable energy research supports the Secretary's objective of providing for energy security for the United States?

Miss Fitzpatrick. The renewable energy technologies represent a potentially important component of the Nation's long term energy supply mix. Additional private and public research will be required to develop the technology base necessary for the private sector to make informed decisions regarding how much this potential can be realized and through which technologies. The budget request represents a commitment by the Department, subject to the Governmentwide need to focus investment in areas suited to a Federal role and to reduce outlays wherever possible, to conducting a balanced research program across a broad cross section of technology options in areas of highest priority. If research is successful, and if industry successfully undertakes the challenge of introducing the resultant technology into the competitive marketplace, renewable energy can result in additional energy supply based on indigenous resources, reduced requirements for long term capital and reduced uncertainty due to its inherent modularity, increased competition within the energy supply infrastructure, and reduced requirements for energy imports. Each of these factors could contribute to a more robust domestic economic and energy economy and reduce the potential for undue reliance on insecure supplies of energy; and thereby promote an increased energy security for the country.

Mr. Bevill. In your opinion, what is the best way to manage a research program?

Miss Fitzpatrick. The Conservation and Renewable Energy organization periodically evaluates priorities within and among technologies from the perspective of the potential longer term competitive energy supply environment, the technological potential of the conservation and renewable energy technology options for competing in this environment, and the scientific and technical obstacles which must be overcome to progress towards realizing these potential payoffs. In the process of developing these priorities; the Department relies upon various sources of information and insights including internal studies, the information provided by university and industry researchers and independent evaluations performed by organizations such as the Energy Research Advisory Board, the National Academy of Sciences, the Electric Power Research Institute. Within the context of Governmentwide resource availability, the Department annually proposes funding for the highest priority of these objectives most suited to the Federal role in energy research. Upon completion of the appropriations process, the Department transfers funds to the portions of the field network most capable of accomplishing the objectives of approved program execution plans. During the course of the research, Departmental staff conduct periodic reviews of the performance within various components of the program and receives continuing feedback from industry and the R&D community on the soundness and relevancy of research results.

Mr. Bevill. Is the manner in which you are managing the solar and renewable energy research program consistent with this approach?

Miss Fitzpatrick. Yes. The Conservation and Renewable Energy programs are extraordinarily broad in scope and the previously described process provides for multiple opportunities for interface between the public and private research community. The management approach is adapted to the needs of each program area.

Mr. Bevill. Did the Department use the same approach to identifying research priorities as was used in preparing the FY 1986 request?

Miss Fitzpatrick. The same general approach was employed to develop consensus with industry on technology development objectives for the past several years.

Mr. Bevill. Have those priorities changed since last year? How?

Miss Fitzpatrick. While annual resources availability may have varied, and progress has changed some of the specific technical issues, the overall program priorities have remained relatively constant over the past couple of years. The need to reduce Federal deficits has required a further focussing of Departmental proposals on those highest technical priorities most suited to the Federal role in energy research. These core priorities have remained essentially constant from FY 1986 to FY 1987.

Mr. Bevill. Can you describe the "innovative cooperative R&D approach" to the Committee? How will it operate? Who will participate? How much is available in the FY 1987 budget for it?

Miss Fitzpatrick. There are a number of variations on this basic concept, which we are currently studying. It may be desirable to leave some flexibility for industry to propose different types of cooperative ventures in different research contexts. For case-descriptions of some types of cooperative R&D ventures, I would refer you to the November 1985 Harvard Business Review and the Winter 1984 Bell Atlantic Quarterly. We are still in the definition phase, and the following discussion should be taken as an outline of thinking to date.

Cooperative R&D ventures in various industries, as implemented under the Cooperative Research Act of 1984, are partnerships registered with the Justice Department that allow multiple industrial participants to cooperate in R&D without violating anti-trust statutes. The cooperation as initially envisioned would be limited to "pre-competitive" -- i.e. not product-specific research. Common practice within private sector ventures is that the partnerships are open to any members willing to share responsibilities according to the venture's charter. While sponsors for such ventures sometimes come from a single industry, in other cases several industries are represented. The venture itself usually retains the intellectual property rights on behalf of the research sponsors, and the organization's charter governs the distribution of royalties or other benefits.

The Department is analyzing the policy, legal, and financial aspects of cooperative R&D ventures in the Solar and Renewable areas. In the final analysis, the types of ventures will depend upon proposals from private partnerships themselves. DOE will be in a position to evaluate the partnership opportunities in the context of its overall R&D plans and criteria. DOE contributions to the partnership could be purely financial, or they may include in-kind contributions such as laboratory facilities or special expertise. Since the cooperative ventures are intended to be "private sector," the DOE would limit itself to a minority position.

Upon completion of our review of the various aspects of renewable energy R&D ventures, the Department will begin a concerted dialogue with industry including publication of a solicitation of general interest to reach consensus as to the best methods for fulfilling the objectives of the initiative. There are no funds specifically designated in the 1987 Solar and Renewable Energy budget for cooperative R&D ventures, but to the extent that attractive proposals are brought forth by private consortia, a reprogramming action could be considered in 1987.

Mr. Bevill. What is the Department's policy in regard to demonstration projects that are currently underway? Does the Department intend to see any of these through to completion? How much has been invested to date in the projects that you are not going to complete?

Miss Fitzpatrick. The Department's view remains constant that demonstrations are properly the responsibility of the private sector. On a case by case basis, the Department may consider participation in integrated proof of concept experiments subject to the availability of Governmentwide resources. The Department currently has sufficient resources to complete its responsibilities relating to technology demonstration projects funded in prior years.

Mr. Bevill. Which solar and renewable projects currently involve or have a requirement of cost-sharing of any kind? What is the status of those cost-sharing agreements?

Miss Fitzpatrick. The Department supports cost-sharing with industry as a vital part of its solar and renewable energy program strategy. Cost-sharing represents an effective method to leverage Federal monies and increase program impact. Examples of the solar and renewable contracts which currently involve cost-sharing with industry include:

Contracts	Industry Cost Share	Status
Solar Buildings		
Lajet Innovative Concentrator	21%	Active
Molten Salt Subsystem/Component Experiments	24%	Active
10MWe Pilot Plant (Solar 1)	15%	Active
Silver Polymer Research	75%	Active
Photovoltaics		
Amorphous Silicon	30%	Active
Biofuels		
Wood Fired Combustion Turbine	80%	Active
Collection & Synthesis of Combustion and Emission Data From a Municipal Waste Plant	80%	Active
Wind		
Compilation of Data From Operational Wind Turbines and Sites to Verify Model Predictions	Various	Active
Geothermal		
Heber Binary Plant	50%	Active
Cascades Research	50%	Active
DOE Drilling Project	50%	Active
EES & Storage		
Sodium Sulfur Batteries	72%	Active
Zinc-Bromine Batteries	57%	Active
Aluminum-Air Batteries	50%	Active

Mr. Bevill. What is the current contribution of solar and renewable energy sources to the total domestic energy production?

Miss Fitzpatrick. Based on information available to the Department, renewable energy contributed 8 to 8.5 percent of national primary energy supply in 1984.

Mr. Bevill. What is the estimated contribution of solar and renewable energy sources to domestic energy production within five years? ten years?

Miss Fitzpatrick. The difficulty of attempting to make dependable forecasts in a highly unpredictable future has been discussed within the energy community on numerous occasions and remains a valid consideration. From the information available to the Department it appears that renewable energy, may represent some 9 percent within the next five years, and 10 to 10.5 percent of the supply mix by the year 2000, and may even reach 13 to 14 percent of domestic primary energy supply by the 2010 timeframe. These estimates, of course, reflect a number of highly uncertain economic and energy assumptions and additionally presume that research will prove successful and that industry will be successful in introducing commercial technology into the competitive marketplace.

Mr. Bevill. What has been the impact on the solar industries as a result of the failure of Congress to extend energy tax credits beyond 1985?

Miss Fitzpatrick. The solar industries encompass a broad range of technologies and entail businesses which range from divisions of larger corporations to more entrepreneurial interests. Data about the effect of the tax credits was sketchy at best during the period the tax credits were in existence. It will be some time before the impacts of the tax credits on industry or the individual technologies will be observable but is likely to depend on the degree to which the industry was dependant on subsidies to sell products and the degree that industry factored tax subsidies into commercial product marketing strategies. The degree of significance of the tax credits to individual technologies ranged from zero to modest or significant. It is our understanding that industry is continuing to offer solar technologies for sale, frequently at increasingly competitive prices and that industry remains involved with DOE funded research programs. The Department continues to view these technologies as important ingredients of the Nation's energy supply mix and considers the correct approach to consist of research and development aimed at technology capable of competing in unsubsidized marketplaces; coupled with timely enactment of basic tax reform of the type proposed by the Administration which will benefit these types of industrial interests.

PROGRAM OVERVIEW

Mr. Bevill. Provide for the record a table showing where FY 1986 and FY 1987 funding will be allocated by laboratory and other activities.

Miss Fitzpatrick. The attached table which summarizes current FY 1986 and proposed FY 1987 Renewable Energy programs by laboratory and other activities is submitted for the record.

ENERGY SUPPLY RESEARCH AND DEVELOPMENT

	OBLIGATIONS		
	FY 1986 ESTIMATE	FY 1987 ESTIMATE	
Solar Energy			
I. Solar buildings energy systems			
ARGONNE NATIONAL LABORATORY			
ARGONNE, IL 12	75	0	1
BROOKHAVEN NATIONAL LABORATORY			
UPTON, NY 01	75	0	2
LOS ALAMOS SCIENTIFIC LABORATORY			
LOS ALAMOS, NM 03	500	200	3
LAWRENCE BERKELEY LABORATORY			
BERKELEY, CA 08	1,240	700	4
MORGAN CORP			
UNDESIGNATED, VA 10	403	0	5
MIDWEST RESEARCH INST			
GOLDEN, CO 05	2,420	2,400	6
NATIONAL BUREAU OF STANDARDS			
WASHINGTON, DC 01	275	150	7
ALL OTHER CONTRACTORS/OBLIGATIONS			
OAKLAND, CA 09	2,995	1,000	8
UNDESIGNATED, ZZ 99	21,479	930	9
TOTAL, ALL OTHER CONTRACTORS/OBLIGATIONS	24,474	1,930	
TOTAL I. Solar buildings energy systems	29,642	5,330	
II. Photovoltaic energy systems			
BATTELLE MEMORIAL INSTITUTE			
RICHLAND, WA 04	95	0	10
BROOKHAVEN NATIONAL LABORATORY			
UPTON, NY 01	270	0	11
MORGAN CORP			
UNDESIGNATED, VA 10	718	290	12

	OBLIGATIONS FY 1986 ESTIMATE	OBLIGATIONS FY 1987 ESTIMATE	
MIDWEST RESEARCH INST			
GOLDEN, CO 05	20.765	17.250	13
NAT'L AERONAUTICS & SPACE ADMIN			
WASHINGTON, DC 01	6.100	0	14
SANDIA LABORATORIES			
ALBUQUERQUE, NM 01	11.640	3.000	15
ALL OTHER CONTRACTORS/OBLIGATIONS			
ALBUQUERQUE, NM 01	3.660	0	16
OAK RIDGE, TN 03	80	0	17
UNDESIGNATED, ZZ 99	-6.050	150	18
TOTAL, ALL OTHER CONTRACTORS/OBLIGATIONS	-2.910	150	
TOTAL II. Photovoltaic energy systems	40.670	20.600	
III. Solar thermal energy systems			
CALCULON CORP			
WASHINGTON, DC 01	3	0	19
PERIHELION CORP			
UNDESIGNATED, WA 16	362	250	20
MIDWEST RESEARCH INST			
GOLDEN, CO 05	11.196	9.400	21
D-E NATIONAL CO			
UNDESIGNATED, CA 99	2.300	1.900	22
SANDIA LABORATORIES			
ALBUQUERQUE, NM 01	10.040	7.300	23
ALL OTHER CONTRACTORS/OBLIGATIONS			
ALBUQUERQUE, NM 01	865	450	24
UNDESIGNATED, ZZ 99	351	0	25
TOTAL, ALL OTHER CONTRACTORS/OBLIGATIONS	1.216	450	
TOTAL III. Solar thermal energy systems	25.085	19.300	

ENERGY SUPPLY RESEARCH AND DEVELOPMENT

	OBLIGATIONS FY 1986 ESTIMATE	OBLIGATIONS FY 1987 ESTIMATE	
IV. Biofuels energy systems			
ARGONNE NATIONAL LABORATORY			
ARGONNE, IL 13	3,740	1,165	26
BATTELLE MEMORIAL INSTITUTE			
RICHLAND, WA 04	1,670	1,000	27
BONNEVILLE POWER ADMINISTRATION			
PORTLAND, OR 03	440	0	28
ERAU 10000 INC			
IDAHO FALLS, ID 02	400	100	29
MIDWEST RESEARCH INST			
GOLDEN, CO 05	7,121	5,765	30
NATIONAL BUREAU OF STANDARDS			
WASHINGTON, DC 01	400	0	31
OAK RIDGE NATIONAL LABORATORY			
OAK RIDGE, TN 03	6,422	3,510	32
SCIENCE APPLICATIONS INC			
UNDESIGNATED, VA 19	190	0	33
TENNESSEE VALLEY AUTHORITY			
UNDESIGNATED, AL 05	810	0	34
UNITE TECHNOLOGY INC			
UNDESIGNATED, IL 05	500	0	35
ALL OTHER CONTRACTORS/OBLIGATIONS			
ALBANY, NY 22	100	0	36
RICHLAND, WA 04	4,500	0	37
UNDESIGNATED, IT 99	1,025	460	38
TOTAL, ALL OTHER CONTRACTORS/OBLIGATIONS	5,625	460	
TOTAL, IV. Biofuels energy systems	27,326	12,200	

ENERGY SUPPLY RESEARCH AND DEVELOPMENT

	OBLIGATIONS		
	FY 1986 ESTIMATE	FY 1987 ESTIMATE	
V. Wind energy systems			
BATTELLE MEMORIAL INSTITUTE			
RICHLAND, WA 04	1,425	1,000	39
COLCOLUM CORP			
WASHINGTON, DC 01	15	0	40
ISE CORP			
RICHLAND, WA 04	20	0	41
KENSUM CORP			
UNDESIGNATED, WA 10	745	250	42
MIDWEST RESEARCH INST			
GOLDEN, CO 05	6,040	5,700	43
NAT'L AERONAUTICS & SPACE ADMIN.			
WASHINGTON, DC 01	11,347	170	44
SANDIA LABORATORIES			
ALBUQUERQUE, NM 04	4,445	770	45
ALL OTHER CONTRACTORS/OBLIGATIONS			
UNDESIGNATED, WA 10	200	100	46
UNDESIGNATED, IT 99	0	260	47
TOTAL, ALL OTHER CONTRACTORS/OBLIGATIONS	200	360	
TOTAL V. Wind energy systems	24,825	8,250	
VI. Ocean energy systems			
ARGONNE NATIONAL LABORATORY			
ARGONNE, IL 13	930	125	48
ENERGY TECHNOLOGY ENGINEERING CENTER			
CANOGA PARK, CA 21	200	0	49
KENSUM CORP			
UNDESIGNATED, WA 10	125	175	50
MIDWEST RESEARCH INST			
GOLDEN, CO 05	3,389	2,250	51

ENERGY SUPPLY RESEARCH AND DEVELOPMENT

	OBLIGATIONS		
	FY 1986 ESTIMATE	FY 1987 ESTIMATE	
TENNESSEE UNIVERSITY OF KNOXVILLE, TN 02	100	0	32
ALL OTHER CONTRACTORS/OBLIGATIONS UNDESIGNATED, ZZ 99	44	0	33
TOTAL VI. Ocean energy systems	4,011	2,500	
VIII. International solar energy program			
SANDIA LABORATORIES ALBUQUERQUE, NM 06	712	250	56
ALL OTHER CONTRACTORS/OBLIGATIONS WASHINGTON, DC 01	250	250	55
TOTAL VIII. International solar energy program	962	500	
IX. Solar technology transfer			
MIDWEST RESEARCH INST GOLDEN, CO 05	2,300	1,400	56
ALL OTHER CONTRACTORS/OBLIGATIONS WASHINGTON, DC 01	600	450	57
UNDESIGNATED, ZZ 99	83	100	58
TOTAL, ALL OTHER CONTRACTORS/OBLIGATIONS	683	550	
TOTAL IX. Solar technology transfer	2,983	1,950	
I. Solar Energy Research Institute			
MIDWEST RESEARCH INST GOLDEN, CO 05	2,244	545	59
TOTAL I. Solar Energy Research Institute	2,244	545	
II. Solar Resource assessment			
BATTELLE MEMORIAL INSTITUTE RICHLAND, WA 04	145	100	60

DIRECT SUPPLY RESEARCH AND DEVELOPMENT

	OBLIGATIONS		
	FY 1986 ESTIMATE	FY 1987 ESTIMATE	
MIDWEST RESEARCH INST			
GOLDEN, CO 05	917	500	44
ALL OTHER CONTRACTORS/OBLIGATIONS			
UNDESIGNATED, II 99	0	100	62
TOTAL, II. Solar Resource assessment	917	700	
III. Process support			
HONEYWELL CORP			
UNDESIGNATED, VA 99	670	500	63
MIDWEST RESEARCH INST			
GOLDEN, CO 05	0	100	64
ALL OTHER CONTRACTORS/OBLIGATIONS			
UNDESIGNATED, CO 05	125	0	65
WASHINGTON, DC 01	3	0	66
UNDESIGNATED, II 99	453	297	67
TOTAL, ALL OTHER CONTRACTORS/OBLIGATIONS	581	297	
TOTAL, III. Process support	1,251	897	
IIII. Process direction			
ALL OTHER CONTRACTORS/OBLIGATIONS			
WASHINGTON, DC 01	4,366	4,100	68
TOTAL, IIII. Process direction	4,366	4,100	
TOTAL, Solar Energy	166,403	73,072	
Geothermal			
I. Hydrothermal industrialization			
HONEYWELL CORP			
UNDESIGNATED, VA 99	133	0	69
NEW YORK STATE UNIVERSITY OF			
UNDESIGNATED, NY 99	1,000	0	70

ENERGY SUPPLY RESEARCH AND DEVELOPMENT

	OBLIGATIONS FY 1986 ESTIMATE	OBLIGATIONS FY 1987 ESTIMATE	
ALL OTHER CONTRACTORS/OBLIGATIONS			
UNDESIGNATED, MI 99	149	0	71
UNDESIGNATED, OR 99	245	0	72
UNDESIGNATED, ZZ 99	7	0	73
TOTAL, ALL OTHER CONTRACTORS/OBLIGATIONS	352	0	
TOTAL i. Hydrothermal industrialization	1,525	0	
ii. Unprocessed resources			
[illegible] INC			
IDAHO FALLS, ID 02	101	0	74
MORGAN CORP			
UNDESIGNATED, VA 10	561	0	75
OAK RIDGE NATIONAL LABORATORY			
OAK RIDGE, TN 03	20	0	76
ALL OTHER CONTRACTORS/OBLIGATIONS			
UNDESIGNATED, ID 02	3,799	3,000	77
UNDESIGNATED, ZZ 99	145	0	78
TOTAL, ALL OTHER CONTRACTORS/OBLIGATIONS	3,944	3,000	
TOTAL ii. Unprocessed resources	4,426	3,000	
iii. Geothermal technology development			
BATTELLE MEMORIAL INSTITUTE			
UPTON, NY 01	250	361	79
RICHLAND, WA 04	462	246	80
TOTAL, BATTELLE MEMORIAL INSTITUTE	812	607	
BROOKHAVEN NATIONAL LABORATORY			
UPTON, NY 01	25	0	81

	OBLIGATIONS		
	FY 1986 ESTIMATE	FY 1987 ESTIMATE	
[illegible]			
[illegible]	1,220	360	02
[illegible]			
[illegible]	6	0	02
[illegible]			
[illegible]	4,220	4,220	04
[illegible]			
[illegible]	1,150	270	05
[illegible]			
[illegible]	100	91	06
[illegible]			
[illegible]	160	0	07
[illegible]			
[illegible]	4,640	2,300	08
[illegible]			
[illegible]	350	0	09
[illegible]			
[illegible]	250	0	10
[illegible]			
[illegible]	450	0	11
[illegible]			
[illegible]	1,500	1,400	12
[illegible]	25	0	13
[illegible]	722	2,360	14
[illegible]	100	0	15
[illegible]	1,726	2,510	99
TOTAL, ALL OTHER CONTRACTORS/OBLIGATIONS	4,329	5,000	
TOTAL III. Geothermal technology development	20,020	14,150	

ENERGY SUPPLY RESEARCH AND DEVELOPMENT

	OBLIGATIONS		
	FY 1986 ESTIMATE	FY 1987 ESTIMATE	
IV. Program direction			
ALL OTHER CONTRACTORS/SUBCONTRACTORS WASHINGTON, DC 01	701	0	99
TOTAL IV. Program direction	701	0	
TOTAL Geothermal	36,600	17,150	
Hydropower			
I. Small scale hydro development			
ESHCO ENGINEERING INC IDAHO FALLS, ID 02	435	0	98
TOTAL I. Small scale hydro development	435	0	
II. Program direction			
ALL OTHER CONTRACTORS/SUBCONTRACTORS WASHINGTON, DC 01	45	0	99
TOTAL II. Program direction	45	0	
TOTAL Hydropower	481	0	
Electric Energy Systems and Storage			
I. Electric energy systems			
ARGONNE NATIONAL LABORATORY ARGONNE, IL 12	300	300	100
BATTELLE MEMORIAL INSTITUTE RICHLAND, WA 04	120	425	100
BROOKHAVEN NATIONAL LABORATORY UPTON, NY 01	400	425	100
CALIFORNIA UNIVERSITY OF BERKELEY, CA 08	171	0	100
CORNELL UNIVERSITY ITHACA, NY 28	100	0	100

ENERGY SUPPLY RESEARCH AND DEVELOPMENT

	OBLIGATIONS		
	FY 1985 ESTIMATE	FY 1987 ESTIMATE	
GENERAL ELECTRIC CO			
SCHENECTADY, NY 01	397	500	105
HUGHES ELECTRONIC CO			
NEWPORT BEACH, CA 01	-352	0	106
HARVEST RESEARCH INST			
IDAHO CITY, ID 01	300	500	107
MASSACHUSETTS INST OF TECH			
CAMBRIDGE, MA 02	712	400	108
NAT'L AERONAUTICS & SPACE ADMIN.			
CLEVELAND, OH 01	550	500	109
NATIONAL BUREAU OF STANDARDS			
WASHINGTON, DC 01	650	700	110
OAK RIDGE NATIONAL LABORATORY			
OAK RIDGE, TN 02	4,372	3,695	111
ROCHESTER UNIVERSITY BOARD, LAB.			
ROCHESTER, NY 02	397	500	112
SANDIA LABORATORIES			
ALBUQUERQUE, NM 01	50	0	113
WASHINGTON UNIVERSITY OF			
ST. LOUIS, MO 01	245	0	114
ALL OTHER CONTRACTORS/OBLIGATIONS			
UNDESIGNATED, CA 37	225	350	115
UNDESIGNATED, CO 99	99	0	116
UNDESIGNATED, DC 01	456	350	117
COLUMBIA, MD 01	43	0	118
UNDESIGNATED, VA 07	267	200	119
ALEXANDRIA, VA 01	362	0	120
UNDESIGNATED, ZZ 99	1,548	29	121
TOTAL, ALL OTHER CONTRACTORS/OBLIGATIONS	3,000	879	
TOTAL 1. Electric power systems	11,508	7,669	

ENERGY SUPPLY RESEARCH AND DEVELOPMENT

	OBLIGATIONS FY 1986 ESTIMATE	OBLIGATIONS FY 1987 ESTIMATE	
II. Energy storage systems			
ARGONNE NATIONAL LABORATORY ARGONNE, IL 13	1,820	747	122
BATTELLE MEMORIAL INSTITUTE RICHLAND, WA 04	1,275	270	123
BROOKHAVEN NATIONAL LABORATORY UPTON, NY 01	1,305	1,210	124
LOS ALAMOS SCIENTIFIC LABORATORY LOS ALAMOS, NM 03	1,125	700	125
LAWRENCE BERKELEY LABORATORY BERKELEY, CA 06	4,400	3,197	126
LAWRENCE LIVERMORE LABORATORY LIVERMORE, CA 07	703	0	127
MIDWEST RESEARCH INST GOLDEN, CO 05	130	130	128
OAK RIDGE NATIONAL LABORATORY OAK RIDGE, TN 03	900	0	129
SANDIA LABORATORIES ALBUQUERQUE, NM 04	4,145	1,827	130
ALL OTHER CONTRACTORS/OBLIGATIONS			131
WASHINGTON, DC 01	0	399	132
COLUMBIA, MD 03	200	0	133
NEWARK, NJ 10	200	0	134
UNDESIGNATED, ZZ 99	477	100	
TOTAL, ALL OTHER CONTRACTORS/OBLIGATIONS	1,005	499	
TOTAL II. Energy storage systems	17,100	9,600	
TOTAL Electric Energy Systems and Storage	28,640	14,219	
Nuclear			
III. Civilian radioactive waste			
BATTELLE MEMORIAL INSTITUTE RICHLAND, WA 04	1,706	0	135

Mr. Bevill. Provide for the record a list of all solar and renewable energy projects that will be completed or terminated in FY 1986 and FY 1987 and indicate the reasons for each.

Miss Fitzpatrick. A number of solar and renewable projects will be completed in FY 1986 and FY 1987 respectively.

In the ocean area, biofouling and corrosion tests for closed cycle heat exchangers being performed at the Seacoast Test Facility will be completed in FY 1986. Material development and waterside enhancement R&D for heat exchangers will be completed in FY 1987. The Seacoast Test Facility cold water pipe enhancement will be completed in FY 1987.

Under the wind program, testing will be completed in the spring of 1986 on the Mod-0 experimental 100KW turbine located at the NASA, Plumbrook Station in Ohio. The testing of the three Mod-2 2.5MW turbines at Goldendale, Washington will be completed late in FY 1986. Documentation of the Mod-5 wind turbine design will be completed in FY 1986 and the project closed out.

For the photovoltaic area, work associated with flat plate crystalline silicon will have successfully completed its ten year development objective and phased out in FY 1986. This includes silicon device processing, ribbon technology, life testing, and systems research. Because the residential experiment stations are predominately associated with this near term technology and because they have successfully completed their test and evaluation objectives, they will also be phased out. Concentrator technology will be terminated as current research results are adequate to support

industrial objective. Finally, the Phase I amorphous silicon effort successfully completes its three year development objectives this year.

In FY 1986 under the biofuels program, research will be completed on the RefCom Project. The private sector has committed to build a commercial facility. The installation of the 3MW wood-fired turbine has already been completed and long term tests will be funded by revenues from generated electricity. The Regional Biomass Program has been established and will be transferred to the private sector for future development. The energy from Waste Water Treatment will be discontinued due to very small energy contribution potential, along with the anaerobic digestion of agricultural residues. The latter project also has a very small energy contribution potential, especially as compared to anaerobic digestion of dedicated herbaceous feedstocks, which is included in the FY 1987 request.

For geothermal R&D, all hydrothermal industrialization programs will be completed. These programs have matured to the point where the States themselves can continue them as their individual needs dictate. Further, under geothermal technology development research on Permeability Enhancement, will be concluded as the result of the establishment of industrial capability in this same area.

Mr. Bevill. Which solar and renewable research projects are closer to commercialization in FY 1986 than they were in FY 1985?

Miss Fitzpatrick. Progress has been maintained in each area of solar and renewable technology since the 1985 timeframe. While significant advances bordering on breakthroughs have occurred in a number of areas; establishing the viability of these technologies as energy supply options will extend beyond the referenced two year period of time. The Department has, therefore, proposed to maintain a reasonably balanced program in FY 1987 which addresses the highest technical and scientific priorities to facilitate moving forward in an orderly yet affordable manner.

SOLAR AND RENEWABLES CONTRACTS

Mr. Bevill. Please provide a list of all contractors and contracts in the solar and renewables program.

Miss Fitzpatrick. The attached listing of all Renewable Energy contractors and contracts is submitted for the record.

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
RENEWABLE ENERGY PROGRAMS
CONTRACTOR LISTING

CONTRACTOR	PROJECT TITLE
ACUREX CORP	THIN FILM MATERIALS RESEARCH F OR LOW COST SOLAR COLLECTORS
ADVANCO CORP	DISH-STIRLING POWER MODULE
AGRI FUELS REFINING CORP	ALCOHOL FUEL LOAN GUARANTEE PR OGRAM
AGRICULTURE DEPARTMENT OF	PRODUCTION OF OILSEED CROPS FO R DIESEL FUEL SUBSTITUTES
AGRICULTURE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
AGRICULTURE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
AGRICULTURE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
AGRICULTURE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
AIR FORCE DEPARTMENT OF	SUPPORT TO SOLAR THERMAL PROGR AM
AIRESEARCH MANUFACTURING CO	SOLAR HYDROGEN PROJECT: CERAMI C HEAT EXCHANGER/ACID VAPORI ZER
ALASKA STATE OF	GEOTHERMAL STUDY OF COPPER RIVER BASIN AREA, ALASKA
ALASKA UNIVERSITY OF	GEOTHERMAL RESOURCE ASSESSMENT RESEARCH
AMERICAN SOC OF HEATING REF	ACTIVE SOLAR DESIGN WORKSHOP
ANALYTIC SCIENCES CORP	DISTURBANCE RECOGNITION AND SY STEM IMPACT EVALUATION

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
RENEWABLE ENERGY PROGRAMS
CONTRACTOR LISTING

CONTRACTOR	PROJECT TITLE
ARCHITECTURAL ENERGY CORP	RESIDENTIAL PASSIVE SOLAR RESE ARCH ACTIVITIES TO SUPPLEMENT IEA TASK VIII SUBTASK B, C, AN
ARCHITECTURAL ENERGY CORP	SUPPORT TO DOE OPERATING AGENT FOR RESIDENTIAL PASSIVE SOLAR STUDIES FOR IEA
ARIZONA STATE UNIVERSITY	SOLERAS SOLAR RESEARCH PROGRAM AT COLLEGES AND UNIVERSITIES
ARIZONA UNIVERSITY OF	SOLERAS SOLAR RESEARCH PROGRAM AT COLLEGES AND UNIVERSITIES
ARIZONA UNIVERSITY OF	K-AR AGE DATING OF YOUNG VOLCA NIC ROCKS
ARMY DEPARTMENT OF	TECHNICAL AND ADMINISTRATIVE S UPPORT FOR THE INTERAGENCY ADV ANCE POWER GROUP AND DATA
ARMY DEPARTMENT OF	FUNDING FOR REAL ESTATE ACQUIS TION
ARMY DEPARTMENT OF	ACQUISITION OF CRIDE OIL
ASSOCIATED UNIVERSITIES INC	OPERATION OF BROOKHAVEN NATION AL LABORATORY
BARBER-NICHOLS ENG CO	SMALL COMMUNITY SOLAR EXPERIME NT - OSAGE CITY, KS.
BATTELLE MEMORIAL INSTITUTE	BATTELLE MEMORIAL INSTITUTE/PA CIFIC NORTHWEST LABORATORY OPERATING AND MANAG
BECHTEL NATIONAL INC	GEOTHERMAL DEEP DRILLING PROJE CT IN THE SALTON SEA GEOTHERMA L AREA

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
RENEWABLE ENERGY PROGRAMS
CONTRACTOR LISTING

CONTRACTOR	PROJECT TITLE
BENDIX FIELD ENGINEERING CORP	PRIME OPERATING CONTRACTOR FOR THE D.O.E. GRAND JUNCTION OFFICE
BINATIONAL SCIENCE FOUNDATION	COOPERATIVE PROJECTS IN ENERGY RESEARCH
BROWN UNIVERSITY	SOLERAS SOLAR RESEARCH PROGRAM AT COLLEGES AND UNIVERSITIES
BROWN UNIVERSITY	TWO PHASE FLOW IN GEOTHERMAL S YSTEMS
BUILDING ENERGY DESIGN TOOL	EVALUATION OF PASSIVE SOLAR DE SIGN TOOLS
BURT HILL KOSAR RITTLEMAN	TECHNICAL SUPPORT TO SOLAR PRO GRAM MANAGEMENT
CABLE TECH LAB INC	DETERMINATION THRESHOLD MAXIMU M OPERATING STRESSES FOR HIG H VOLTAGE INSULATING SYSTEMS
CALCULON CORP	SUPPORT SERVICES - ADP AND TEL ECOMMUNICATIONS
CALIFORNIA STATE OF	INVESTIGATION OF HEAT FLOW REG IME OF GEOTHERMAL GEYSERS
CALIFORNIA UNIVERSITY OF	DISTRUBANCE RECOGNITION AND SY STEM IMPACT
CALIFORNIA UNIVERSITY OF	OPERATION OF LAWRENCE BERKELEY AND LAWRENCE LIVERMORE LABO RATORIES
CALIFORNIA UNIVERSITY OF	LABORATORY OF NUCLEAR MEDICINE AND RADIATION BIOLOGY
CALIFORNIA UNIVERSITY OF	OPERATION OF BERKELEY

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
RENEWABLE ENERGY PROGRAMS
CONTRACTOR LISTING

CONTRACTOR	PROJECT TITLE
	NATIONAL LABORATORY
CALIFORNIA UNIVERSITY OF	EFFECT OF X-RADIATION ONTHE WO RK CAPACITY AND LONGEVIT Y OF THE D OG
CALIFORNIA UNIVERSITY OF	APPLICATION OF PETROLOGY AND G EOCHEMISTRY TO THE STUDY OF GEOTHERMAL RESERVOIRS
CALIFORNIA UNIVERSITY OF	MEASUREMENTS OF GRAVITY AT TH E GEYSERS GEOTHERMAL FIELD
CALIFORNIA UNIVERSITY OF	CHEMICAL MODELING OF GEOTHERMA L FLUID CONSTITUENT BEHAVIOR
CENTRAL FLORIDA UNIVERSITY OF	PHOTOVOLTAIC SOUTHEAST RESIDEN TIAL EXPERIMENT STATION
CHARLES A BANKSTON INC	TECHNICAL SERVICES AND ADMINIS TRATIVE SUPPORT FOR IEA TASK V II
CHICAGO UNIVERSITY OF	OPERATION OF ARGONNE NATIONAL LABORATORY
CHICAGO UNIVERSITY OF	SOLERAS SOLAR RESEARCH PROGRAM AT COLLEGES & UNIVERSITIES
CHICAGO UNIVERSITY OF	ADVANCED EVACUATED TUBULAR CON CENTRATOR RESEARCH
CHILTON ENGINEERING	GEOTHERMAL HEATING OF SALEM PL AZA CONDOMINIUM COMPLEX RENO NV
COLORADO STATE UNIVERSITY	DATA COLLECTION AND ANALYSIS A T THE CSU REPEAT FACILITY
COLORADO STATE UNIVERSITY	TESTING EVALUATION

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
RENEWABLE ENERGY PROGRAMS
CONTRACTOR LISTING

CONTRACTOR	PROJECT TITLE
	OPTIMIZING PERFORMANCE OF SOLAR HEATING AND COOLING D IVISION
COLORADO UNIVERSITY OF	INVESTIGATION OF THE MAXIMUM T OLERABLE LEVEL OF VOLTAGE AN D CURENT HARMONICS
COMMERCE DEPARTMENT OF	EXHIBITION AND PROMOTION OF RE S - PRODUCTS, SERVICES, SYST EMS AND TECHNOLOGIES.
COMMERCE DEPARTMENT OF	LOUISIANA SUBSIDENCE LEVELING
COMMERCE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
COMMERCE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
COMMERCE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
COMMERCE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
COMMERCE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
COMMERCE DEPARTMENT OF	IMPLEMENT STRAGETIC PETROLEUM RESERVE.
CONEG POLICY RESEARCH CENTER	REGIONAL BIOMASS PROGRAM - FUN DING FOR NORTHEAST AREA OF NORTHERN TIER STATES.
CORNELL UNIVERSITY	A POSTURING STRATEGY FOR ELECT RICAL UTILITY SYSTEMS
COUNCIL GREAT LAKES GOVERNORS	REGIONAL BIOMASS PROGRAM - FUN DING FOR GREAT LAKES STATES.

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
RENEWABLE ENERGY PROGRAMS
CONTRACTOR LISTING

CONTRACTOR	PROJECT TITLE
DAYTON UNIVERSITY OF	LAB EVALUATION OF SOLAR INCINE RABILIBITY OF HAZARDOUS ORGANI C WASTES
DEFENSE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
DEFENSE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
DEFENSE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
DEFENSE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
DEFENSE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
DEFENSE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
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DEFENSE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
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ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
RENEWABLE ENERGY PROGRAMS
CONTRACTOR LISTING

CONTRACTOR	PROJECT TITLE
DEFENSE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
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DEFENSE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
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DEFENSE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
DENVER UNIVERSITY OF	EFFECTS OF INTERLAYER AND SUBS TITUTIONAL DOPANB ON THERMOP HYSICAL PROPER TIES OF SOLID
DEPARTMENT OF AGRICULTURE	DEVELOPMENT AND TESTING FO WIN D ENERGY TECHNOLOGY FOR AGRICU LTURAL APPLICATIONS
DREXEL UNIVERSITY	RESEARCH ON CONTROL OF ACTIVE SOLAR SPACE CONDITIONING SYS TEMS
DUKE UNIVERSITY	STUDIES OF NUCLEAR STRUCTURE U SING NEUTRONS AND CHARGED PARTICLES
EATON OPERATING CO INC	R & D GEOPRESSURED GEOTHERMAL SITES
EG & G IDAHO INC	PRIME OPERATING CONTRACTOR FOR THE INEL
EG & G INC	TIMING AND FIRING, PHOTOGRAPHY , ELECTRONIC SUPPORT, AND RE LATED

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
RENEWABLE ENERGY PROGRAMS
CONTRACTOR LISTING

CONTRACTOR	PROJECT TITLE
	SCIENTIFIC OPERATIONS.
ELECTROTEK CONCEPTS INC	TECHNICAL AND ANALYTICAL SUPPO RT IN THE AREAS OF POWER SYSTE MS RESEARCH
ENERGETICS INC	TECHNICAL SUPPORT IN THE AREAR S OF ELECTRIC ENERGY SYSTEMS
ENTECH INC	INNOVATIVE POINT FOCUS SOLAR C ONCENTRATOR
FEDERAL ENERGY MGT AGENC	FEDERAL BUILDINGS PROGRAM
FENIX & SCISSON INC	ENGINEERING SUPPORT FOR DRILLI NG AND MINING ACTIVITIES.
FLORIDA STATE UNIVERSITY	RESEARCH IN NUCLEAR CHEMISTRY
FLORIDA UNIVERSITY OF	RADIATION CHEMISTRY OF HYDROCA RBON AND ALKYL HALIDE SYSTEM
FORD AEROSPACE COMMUNICATIONS	SMALL COMMUNITY EXPERIMENT CON STR. INSTALL & CHECKOUT
GA TECHNOLOGIES INC	SOLAR HYDROGEN PROJECT
GENERAL ELECTRIC CO	R AND D FOR ONLINE DETECTION O F SYSTEM INSTABILITIES
GENERAL ELECTRIC CO	STUDY OF ELECTRIC FIELD AND IO N EFFECTS OF HVDC LINES FROM T 600KV TO T 1500KV
GENERAL SERVICES ADMIN	UTILITY SERVICES
GENERAL SERVICES ADMIN	FEDERAL BUILDINGS PROGRAM
GENERAL SERVICES ADMIN	FEDERAL BUILDINGS PROGRAM

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CONTRACTOR LISTING

CONTRACTOR	PROJECT TITLE
GENERAL SERVICES ADMIN	FEDERAL BUILDINGS PROGRAM
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GENERAL SERVICES ADMIN	FEDERAL BUILDINGS PROGRAM

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GENERAL SERVICES ADMIN	FEDERAL BUILDINGS PROGRAM
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GENERAL SERVICES ADMIN	FEDERAL BUILDINGS PROGRAM
GENERAL SERVICES ADMIN	FEDERAL BUILDINGS PROGRAM
GENERAL SERVICES ADMIN	FEDERAL BUILDINGS PROGRAM
GEO OPERATOR CORP	CASCADE GEOTHERMAL DRILLING
GEOPRODUCTS CORP	PRECONSTRUCTION OF THE HONEY LAKE HYBRID POWER PLANT
GEORGIA RESEARCH FDN UNIV OF	FUNDAMENTAL STUDIES OF SEPARAT ION PROCESSES
GEORGIA RESEARCH FDN UNIV OF	STUDY OF MECHANISMS OF HYDROGE N DIFFUSION IN SEPARATION DEVICES

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
RENEWABLE ENERGY PROGRAMS
CONTRACTOR LISTING

CONTRACTOR	PROJECT TITLE
GEORGIA RESEARCH FDN UNIV OF	MICROBIOLOGY AND PHYSIOLOGY OF ANAEROBIC FERMENTATIONS OF CELLULOSE
GERSHON MECKLER ASSOC	DATA COLLECTION AND MODEL DEVE LOPMENT OF LIQUID DESICCANT INTEGRATED HVA C SYSTEM
HAWAII ELECTRIC CO	HAWAIAN DEEP WATER ELECTRICAL TRANSMISSION CABLE PROGRAM (PHASE IIA).
HAWAII UNIVERSITY OF	PUNA GEOTHERMAL RESEARCH FACIL ITY TECHNOLOGY TRANSFER PROGRA M
HAWAII UNIVERSITY OF	GEOTHERMAL RESEARCH AT THE PUN A FACILITY
HEALTH & HUMAN SERVICES DEPT	FEDERAL BUILDINGS PROGRAM
HEALTH & HUMAN SERVICES DEPT	FEDERAL BUILDINGS PROGRAM
HEALTH & HUMAN SERVICES DEPT	FEDERAL BUILDINGS PROGRAM
HEALTH & HUMAN SERVICES DEPT	FEDERAL BUILDINGS PROGRAM
HEALTH & HUMAN SERVICES DEPT	FEDERAL BUILDINGS PROGRAM
HEALTH & HUMAN SERVICES DEPT	FEDERAL BUILDINGS PROGRAM
HOLMES & NARVER INC	PERFORM MANAGEMENT ENGINNEERIN G TECHNICAL SUPPORT COMMUNICAT IONNS CONSTRUCTION MATERIAL TE
HOWARD UNIVERSITY	LABORATORY IMPROVEMENT AND RES EARCH PROGRAM

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
RENEWABLE ENERGY PROGRAMS
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CONTRACTOR	PROJECT TITLE
	PHASE A
IDAHO STATE OF	GEOTHERMAL RESOURCE EVALUATION IN IDAHO
INTERIOR DEPARTMENT OF	MUNICIPAL SOLID WASTE (MSW) CO MBUSTION RESIDUE RESEARCH
INTERIOR DEPARTMENT OF	RESEARCH ACTIVITIES OF THE U.S . NATIONAL COMMITTEE FOR RACK MECHANICS
INTERIOR DEPARTMENT OF	PROVIDE PRE AND POST SHOT GEOL OGICAL DATA AND STUDY HYDROL OGIC DATA RELATED TO UNDERGROU
INTERIOR DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
INTERIOR DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
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RENEWABLE ENERGY PROGRAMS
CONTRACTOR LISTING

CONTRACTOR	PROJECT TITLE
INTERIOR DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
IOWA STATE UNIVERSITY	MULTI-PROGRAM NATIONAL LABORAT ORY DEALING PRIMARILY IN PHY SICAL RESEARCH INCLUDING RARE
ISRAEL STATE OF	SIMULATION AND ANALYSIS OF HIG H ENERGY EFFICIENCY ABSORPTION SYSTEMS FOR SOLAR COOLING
JUSTICE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
JUSTICE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
JUSTICE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
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JUSTICE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
JUSTICE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
JUSTICE DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
LA JET ENERGY CO	INNOVATIVE POINT FOCUS SOLAR C ONCENTRATOR
LABOR DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
LABOR DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM

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RENEWABLE ENERGY PROGRAMS
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CONTRACTOR	PROJECT TITLE
LABOR DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
LABOR DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
LABOR DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
LABOR DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
LOUISIANA BIO-FUEL INC	FEASIBILITY STUDY FOR ETHANOL PLANT NEAR NEW ORLEANS LOUISIANA
LOUISIANA STATE UNIVERSITY	THEORETICAL STUDIES OF EXCESS ELECTRONS IN FLUIDS, STRUCTURE AND ELECTRON TRANSFE
LOUISIANA STATE UNIVERSITY	ENVIRONMENTAL MONITORING AT GEOPRESSURED WELL SITES
MARYLAND UNIVERSITY OF	RADIOACTIVE DECAY STUDIES AT T RISTAN-II
MASSACHUSETTS INST OF TECH	SUPERCONDUCTING GENERATOR PROJ ECT
MASSACHUSETTS INST OF TECH	SOLAR PHOTOVOLTAIC RESIDENTIAL PROJECT
MEAD DATA CENTRAL	PROVIDE AXXESS TO LEXISTNEX IS LEGAL RESEARCH SERVICES AT TH HE NEGOTIATED PRICES BETWEEN F
MERIDIAN CORP	TECHNICAL ANALYSIS AND MANAGEM EHT SUPPORT SERVICES FOR RENEW ABLE ENERGY.
MERIDIAN CORP	TECHNICAL ANALYSIS AND MGMT SU PPORT FOR THE RENEWABLE ENERGY PROGRAM

CONTRACTOR	PROJECT TITLE
	AREAS
MIDWEST RESEARCH INST	IMMUNOLOGICAL AND BIOCHEMICAL EFFECTS OF 60HZ ELECTRIC AND M AGNETIC FIELDS IN HUMANS
MIDWEST RESEARCH INST	OPERATION OF SOLAR ENERGY RESE ARCH INSTITUTE
MONTANA COLL OF MINERAL SCI	GEOPHYSICAL RESEARCH ON GEOTHERMAL RESOURCES IN MONTANA
NAHB RESEARCH FOUNDATION	DEVELOP AN INDUSTRY BASED RESI DENTIAL BUILDING THERMAL PERFO RMANCE EVALUATION PROGRAM
NASA	SOLAR THERMAL DISTRIBUTED SYST EMS PROGRAM DEVELOPMENT OF STIRLING ENGINE TECHNOLOGY FOR
NASA	FLAT PLATE SOLAR PHOTOVALTAIC RESEARCH AT JPL
NASA	MARSHALL SPACE FLIGHT CENTER S UPPORT OF THE DMONSTRATION OF SOLAR HEATING AND COOLING I
NASA	DIPECT HEATING AND CONVERSION AND CHEMICAL PROCESSES.
NASA	SUPPORTING RESEARCH AND TECHNO LOGY PROJECT PLAN.
NASA	COMMUNICATIONS AND CONTROL FOR POWER DISTRIBUTION SYSTEMS
NATIONAL ACADEMY OF SCIENCES	REVIEW AND ANALYSIS OF ENERGY SYSTEMS RESEARCH

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ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
RENEWABLE ENERGY PROGRAMS
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CONTRACTOR	PROJECT TITLE
NATIONAL BUREAU OF STANDARDS	BUILDING ENERGY CONSERVATION C RITERIA
NAVY DEPARTMENT OF	STUDIES OF HYDROGENATED AMORPH OUS SILICON
NEVADA UNIVERSITY OF	GEOTHERMAL ENHANCEMENT OF MINE RAL PROCESSING IN NEVADA
NEW ENERGY CO OF INDIANA	ALCOHOL FUEL LOAN GUARANTEE PR OGRAM.
NEW MEXICO ENERGY R & D INST	NEW MEXICO STATEWIDE GEOTHERMAL ENERGY PROGRAM
NEW MEXICO STATE OF	GEOTHERMAL DEMONSTRAION POWER PLANT
NEW MEXICO STATE UNIVERSITY	SOUTHWEST PHOTOVOLTAIC RESIDEN TIAL EXPERIMENT STATION OPERATION
NEW MEXICO UNIVERSITY OF	SPECIAL RESEARCH & DEVELOPMENT /ALTERNATE ENERGY
NEW MEXICO UNIVERSITY OF	THE PHOTODETACHMENT SPECTR UM OF H-NEGATIVE
NEW YORK STATE OF	COMBUSTION/EMISSIONS RESEARCH (PITTSFIELD FAC.)
NEW YORK STATE OF	EXTRACTION OF HYDROTHERMAL ENERGY FROM BASAL CAMBRIAN FORMATIONS IN THE APPALACIAN
NORTH CAROLINA STATE UNIV	NUCLEAR STRUCTURE RESEARCH
NORTH CAROLINA UNIVERSITY OF	STUDIES OF NUCLEAR PROCESSES
NORTH CAROLINA UNIVERSITY OF	EXPERIMENTAL STUDIES OF ATOMIC INNER SHELL

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RENEWABLE ENERGY PROGRAMS
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CONTRACTOR	PROJECT TITLE
	IONIZATION PHENOMENA
NORTH CAROLINA UNIVERSITY OF	ENERGY CONVERSION BASED ON MOL ECULAR EXCITED STATES
NORTH DAKOTA UNIVERSITY OF	GEOTHERMAL RESOURCE ASSESSMENT RESEARCH
OHIO STATE UNIV RESEARCH FDN	SOLERAS SOLAR RESEARCH PROGRAM AT COLLEGES AND UNIVERSITIES
OKLAHOMA UNIVERSITY OF	TRANSITIONAL NUCLEI IN THE AZ1 00 REGION, STUDIES OF NEUTRON RICH SR ISOTOPES
OREGON INST OF TECHNOLOGY	TECHNOLOGY TRANSFER & INFORMATION DISSEMINATION
OREGON STATE OF	GEOTHERMAL RESEARCH, OREGON CASCADES
OSAGE CITY CITY OF	SMALL COMMUNITY SOLAR EXPERIME NT - SITE ACTIVITIES
PAGOSA SPRINGS TOWN OF	GEOTHERMAL DEMONSTRATION PROJECT
PENNSYLVANIA STATE UNIVERSITY	CONTINUTED RESEARCH ON DIRECT CONTACT HEAT EXCHANGERS FOR GEOTHERMAL APPLICATIONS
PHIBRO/LAFCO	FEASIBILITY STUDY FOR ETHANOL PLANT NEAR NEW ORLEANS LOUISIANA
PHILLIPS PETROLEUM CO	MARINE/TERMINALLING SERVICE TO FILL DOE STRATEGIC PETRO- LUEM RESERVES AT BRYAN MOUND
PRINCETON UNIVERSITY	SOLERAS SOLAR RESEARCH PROGRAM AT COLLEGES &

CONTRACTOR	PROJECT TITLE
	UNIVERSITIES
PUBLIC SVC ELECTRIC & GAS CO	CONSTRUCTION OF A BATTERY ENER GY STORAGE TEST FACILITY
RADIAN CORP	MATERIAL ANALYSIS SERVICES IN SUPPORT OF DOE'S HEBER BINARY GEOTHERMAL DEMONSTRATION POWER
REYNOLDS ELEC & ENG CO INC	WEAPONS TEST SUPPORT SERVICES AT NTS AND OTHER ASSIGNED LOCA TIONS.
REYNOLDS METALS CO	THIN FILM MATERIALS RESEARCH
ROCHESTER UNIVERSITY OF	BIOLOGICAL RESEARCH
ROCKWELL INTERNATIONAL CORP	MANAGEMENT,OPERATION, AND MAIN TENANCE OF ROCKWELL'S ENERGY T ECHNOLOGY ENGINEERING CENTER (
SAN DIEGO GAS & ELECTRIC CO	GEOTHERMAL BINARY DEMONSTRATIO N PROJECT PLANT
SBA & SRA TECHNOLOGIES INC	WIND TECHNOLOGY PROGRAM DOCUME NTATION AND TECHICAL ANALYSIS
SCHIFF HARDIN & WAITE	LEGAL SUPPORT SERVICES FOR THE DOE ALCOHOL FUELS LOAN GUARUNTEE PROGRAM
SCIENCE APPLICATIONS INC	PLANNING OPERATION AND MAINTEN ANCE OF USDOE'S NATIONAL EXHIBITS PROGRAM.
SES CORP	ASSESSMENT OF OPERATIVE MECHAN ISMS TO EXPEDITE OPPORTUNITIES FOR THE

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
RENEWABLE ENERGY PROGRAMS
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CONTRACTOR	PROJECT TITLE
	PRIVATE SECTOR TO UTI
SHAH & ASSOC INC	ASSESSMENT AND IMPLEMENTATION OF ELECTRIC POWER PROGRAM AT H ISTORICALLY BLACK COLLEGES AND
SMITHSONIAN INSTITUTION	BIBLIOGRAPHY (VOLCANIC ACTION)
SMITHSONIAN INSTITUTION	A PRIMARY LIGHT HARVESTING SYS TEM PHYCOBILISOMES AND ASSOCIATED MEMBRANES
SMUD	PHASE II ONE MW PHOTOVOLTAIC P OWER FIELD
SOLAR AMERICA CO INC	SOLAR INFORMATION SYSTEMS, CONSERVATION AND RENEWABLE ENERGY INQUIRY AND REFERRAL
SOUTH DAKOTA STATE OF	STATE GEOTHERMAL COMMERCIALIZA TION PLANNING FOR SOUTH DAKOTA
SOUTHERN CALIFORNIA EDISON CO	DYNAMIC RESPONSE OF A 330 KW H ORIZONTAL AXIS WIND TURBINE GENERATOR
SOUTHERN CALIFORNIA EDISON CO	FABRICATION OF DISPLAYS
SOUTHERN METHODIST UNIVERSITY	GEOTHERMAL MAP OF THE UNITED STATES
SOUTHWEST RESEARCH INSTITUTE	STUDY OF THE BEHAVORIAL AND BI OLOGICAL EFFECTS OF HIGH INTENSITY 60 HZ ELECTRIC FIELD
SOUTHWESTERN LOUISIANA UNIV	A STUDY OF HYDROCARBONS ASSOCIATED WITH BRINES FROM DOE GEOPRESSURED

CONTRACTOR	PROJECT TITLE
	WELLS
STANFORD UNIVERSITY	STUDIES ON THE REPAIR OFDAMAGE D DNA IN BACTERIOPHAG E, BACTERI AL AND MAMMALIAN S
STANFORD UNIVERSITY	INTERPRETATION OF SINGLE WELL TRACER TESTS
STANFORD UNIVERSITY	STANFORD GEOTHERMAL PROGRAM FO R GEOTHERMAL RESERVOIR ENGIN EERING RESEARCH
STEVEN WINTER ASSOC INC	SUPPORT SERVICES FOR PASSIVE S OLAR THERMAL RESEARCH
SUNBELT ENERGY CORP	FEASIBILITY STUDY FOR CORN TO ETHANOL PLANT IN PANOLA COUNTY MISSISSIPPI
SYSTEMATIC MANAGEMENT SERVICES	PROJECT CONTROL SUPPORT SERVIC ES
T S INFOSYSTEMS INC	TECHNICAL AND FINANCIAL REVIEW AND ASSESSMENT OF ALCOHOL FUE L LOAN GUARANTEE PROGRAM
TECHNECON ANALYTIC RES INC	TECHNOLOGY TRANSFER STUDY FOR THE HEBER BINARY CYCLE GEOTHER MAL DEMONSTR ATION PLANT
TENNESSEE UNIVERSITY OF	RESEARCH CONCERNING IONIC AND FREE RADICAL REACTIONS IN RADIATION CHEMISTRY
TENNESSEE UNIVERSITY OF	PHYSICAL-CHEMICAL STUDIES OF T RANSURANIUM ELEMENTS
TENNESSEE VALLEY AUTHORITY	TECHNICAL MONITORING OF THE AL COHOL FUELS OFFICE

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
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CONTRACTOR	PROJECT TITLE
	(AFO) ALC OHOL FUEL PLANT LOAN GUARANTEE
TENNESSEE VALLEY AUTHORITY	TVA REGIONAL BIOMASS PROGRAM
TENNESSEE VALLEY AUTHORITY	FEDERAL PHOTOVOLTAIC UTILIZATI ON PROGRAM (CYCLE 3)
TENNESSEE VALLEY AUTHORITY	FEDERAL BUILDINGS PROGRAM
TENNESSEE VALLEY AUTHORITY	FEDERAL BUILDINGS PROGRAM
TENNESSEE VALLEY AUTHORITY	FEDERAL BUILDINGS PROGRAM
TENNESSEE VALLEY AUTHORITY	FEDERAL BUILDINGS PROGRAM
TENNESSEE VALLEY AUTHORITY	FEDERAL BUILDINGS PROGRAM
TENNOL INC	1LCOHOL FUELS LOAN GURANTEE
TEXAS A & M RESEARCH FDN	A STUDY OF CATALYSTS AND MECHA NISMS IN SYNTHESIS REACTIONS
TEXAS UNIVERSITY OF	U.S. GULF COAST GEOPRESSURED- GEOTHERMAL PROGRAM
THERMAL POWER CO	CASCADE GEOTHERMAL DRILLING
TPI INCORPORATION	ADMIN/TECH DOE/SAH
TRANSPORTATION DEPARTMENT OF	DOE/DOT - UMTA INTERAGENCY AGR EEMENT
TRANSPORTATION DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
TRANSPORTATION DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM

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CONTRACTOR	PROJECT TITLE
TRANSPORTATION DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
TREASURY DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
TREASURY DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
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TREASURY DEPARTMENT OF	IA WITH U.S. DEPT OF THE TREAS URY
TREASURY DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
TREASURY DEPARTMENT OF	FEDERAL BUILDINGS PROGRAM
TUFTS UNIVERSITY	OPTICS & MATERIALS

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
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CONTRACTOR	PROJECT TITLE
	RESEARCH FO R CONTROLLED RADIANT ENERGY TR AHSFER
UNIVERSITIES RESEARCH ASSOC	OPERATION OF FERMI NATIONAL AC CELERATOR LAB
UTAH STATE OF	UTAH STATE PRISON GEOTHERMAL PROJECT
UTAH STATE OF	GEOTHERMAL STUDIES IN UTAH
UTAH UNIVERSITY OF	GEOSCIENCE RESEARCH & DEVELOPM ENT
UTAH UNIVERSITY OF	RESEARCH AND TECHNOLOGY DEVELO PMENT FOR GEOTHERMAL ENERGY
VETERANS ADMINISTRATION	TISSUE INTERRACTION WITH HONIO NIZING ELECTROMAGNETIC FIELDS
VETERANS ADMINISTRATION	FEDERAL BUILDINGS PROGRAM
VETERANS ADMINISTRATION	FEDERAL BUILDINGS PROGRAM
VETERANS ADMINISTRATION	FEDERAL BUILDINGS PROGRAM
VETERANS ADMINISTRATION	FEDERAL BUILDINGS PROGRAM
VETERANS ADMINISTRATION	FEDERAL BUILDINGS PROGRAM
VETERANS ADMINISTRATION	FEDERAL BUILDINGS PROGRAM
VIRGINIA POLYTECH INST/ST UNIV	REAL TIME MEASUREMENTS IN POWE R SYSTEMS
VSE CORP	TECHNICAL AND MANGEMENT SUPPOR T TO EES IN CONNECTION WITH TH E

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY
RENEWABLE ENERGY PROGRAMS
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CONTRACTOR	PROJECT TITLE
	HAWAIIAN DEEP WATER CABLE PR
W/L ASSOC LTD	ELECTRIC FIELD EFFECTS RESEARC H PROGRAM SUPPORT SERVICES.
WASHINGTON STATE OF	GEOTHERMAL RESEARCH DEVELOPMENT
WASHINGTON UNIVERSITY	ON LINE DETECTION OF SYTEM INS TABILITIES
WELL PRODUCTION TESTING	DRILLING SUPERINTENDENT FOR SA LTON SEA DEEP DRILLING PROJE CT
WESTEC SERVICES INC	OPERATIONS AND MANGEMENT
WESTEC SERVICES INC	OPERATION AND MAINTENANCE OF D OE'S GEOTHERMAL TEST FIELDS
WESTINGHOUSE ELECTRIC CORP	INVESTIGATION OF MUNICIPAL SOL ID WASTE ENERGY RECOVERY PROCE SS IN A SUBSCALE ROTARY COMBUS
WESTINGHOUSE HANFORD CO	OPERATION OF THE HANFORD ENGIN EERING DEVELOPMENT LABORATORY
WILLIAM & MARY COLLEGE OF	THE MEASUREMENT OF ABSOLUTE TO TAL DETACHMENT AND CROSS SECTIONS OF NEGATIVE IONS FOR
WISCONSIN UNIVERSITY OF	RESEARCH ON ACTIVE SOLAR PROCE SSES
WYOMING UNIVERSITY OF	GEOTHERMAL STUDIES IN THE JACKSON HOLE AREA WYOMING

PROGRAM OVERVIEW--SOLAR AND RENEWABLES

Mr. Bevill. For each individual activity identified in the solar and renewables budget, provide FY 1985, 1986 and 1987 budget actuals and requests, where and how the funds will be spent and how many man years of effort are involved.

Miss Fitzpatrick. The attached data, which includes FY 1985, FY 1986 and FY 1987 funding for Renewable Energy programs is submitted for the record.

RENEWABLE ENERGY
ESTIMATED MAN YEARS OF EFFORT

	FY1987 REQUEST			ESTIMATED MAN YEARS OF EFFORT		
	FY1985	FY1986	FY1987	FY1985	FY1986	FY1987
ELECTRIC ENERGY SYSTEMS	$19,717	$11,548	$7,619	232	136	90
ENERGY STORAGE SYSTEMS	18,642	17,292	8,600	219	203	101
GEOTHERMAL	29,698	26,681	17,930	349	314	211
SOLAR	171,587	144,624	72,292	2,019	1,701	850
HYDROPOWER	447	481	0	5	6	0
GRDF	121	69	72	1	1	1
TOTAL	$240,212	$200,695	$106,513	2,825	2,361	1,253

REPORT C1514552

U. S. DEPARTMENT OF ENERGY
DEPUTY ASSISTANT SECRETARY FOR RENEWABLE ENERGY
OFFICE OF RENEWABLE TECHNOLOGIES
DIVISION OF BIOFUELS & MUNICIPAL WASTE TECHNOLOGY

FY 85 PROCUREMENT EXECUTION REPORT
AS OF : 03/13/86

EB24:ACTIVITY NAME: BIOMASS AND ALCOHOL

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2400000 CS83013 WAS DI98 AGRICULTURE DEPT OF NO COST EXTENSION TO 12/85	014	0	0	0	0	WHQ	O'CONNELL
EB2400000 CHENG38 ANL IL13 ARGONNE NATIONAL LAB BIOCHEM RESEARCH-MSW	001	908	575	1,150	310	CHO	LAILAS N
EB2400000 CHENG38 ANL IL13 ARGONNE NATIONAL LAB ASSESSMENT OF BIOMASS TECH	004	940	940	940	0	CHO	BERGER B
EB2400000 CHENG38 ARGONNE NATIONAL LAB BIOCHEM & THERMOCHEM RES MSW	005	54	54	0	0	CHO	WALTER D
EB2400000 CHENG38 ANL IL13 ARGONNE NATIONAL LAB MUNICIPAL SOLID WASTE	038	1,155	1,155	1,350	535	CHO	KOUTS C

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EB24:ACTIVITY NAME: BIOMASS AND ALCOHOL

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2400000 CS84029 BPA OR03 BONNEVILLE POWER ADMIN BIOMASS REGIONAL PROGRAM(NW)	001	1,350	1,350	440	0	WHQ	O'CONNELL
EB2400000 HA32625 WAS DI98 CALCULON DISPLAY WRITER/PC SUPPORT	007	5	5	0	0	WHQ	BACK P
EB2400000 CE30837 WAS DI98 DOE ADMINISTRATIVE SERVICES PRINTING CHARGE	005	1	1	10	0	WHQ	WALTER D
EB2400000 CE30850 GOVERNMENT PRINTING OFF BIOFUELS RESERVE	001	2	2	0	0	WHQ	BERGER B
EB2400000 CE30784 ZZOTH VG10 MERIDIAN CORP RE SUPPORT SERVICE (BIOFUELS)	008	877	877	0	0	WHQ	LOOSE R

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EB24:ACTIVITY NAME: BIOMASS AND ALCOHOL

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2400000 CE30851 MINES BUREAU OF MSW ASH STUDY	001	50	50	0	0	WHQ	WALTER D
EB2400000 CS20178 MITRE CORP ENERGY CONSERVATION WASTE UTIL R&D PLAN	001	2	2	0	0	WHQ	WALTER D
EB2400000 CE30838 ALBA NO23 NEW YORK STATE ERDA COMBUSTION/EMISSIONS RESEARCH	001	50	50	0	0	WHQ	WALTER D
EB2400000 ORENG26 OAKR TN03 OAK RIDGE NATIONAL LAB SHORT ROTATION WOODY CROPS	002	2,516	2,300	4,120	2,250	ORO	SPRAGUE S
EB2400000 ORENG26 OAK RIDGE NATIONAL LAB SHORT ROTATION WOODY CROPS	005	136	136	0	0	ORO	SPRAGUE S

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EB24:ACTIVITY NAME: BIOMASS AND ALCOHOL

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY / CONG.	STATE	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2400000	OREN026	OAKR	TN03							
OAK RIDGE NATIONAL LAB										
PLANT PRODUCTION (ON-FARM HERB)				027	1,710	1,710	1,300	1,260	ORO	PLANT PROD
EB2400000	OREN026	OAKR	TN03							
OAK RIDGE NATIONAL LAB										
IEA-FOREST ENERGY				064	160	160	160	0	ORO	O'CONNELL
EB2400000	OR21400	OAKR	TN03							
OAK RIDGE NATIONAL LAB										
SHORT ROTATION WOODY CROPS (HBCU)				033	365	365	150	0	ORO	SPRAGUE S
EB2400000	YBD0000	OAKR	TN03							
OAK RIDGE OPER OFFICE										
REGIONAL BIOMASS(EAST/MIDWEST,-100 GRH)				003	1,350	1,350	692	0	ORO	O'CONNELL
EB2400000	RL01830									
PACIFIC NORTHWEST LABS										
GASIFICATION & LIQUIFICATION R&D				002	5,300	5,300	630	1,000	RLO	FRIEDRICH

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EB24:ACTIVITY NAME: BIOMASS AND ALCOHOL

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2400000 RL01830 PACIFIC NORTHWEST LABS FEEDSTOCK STUDIES	019	200	200	0	0	RLO	FRIEDRICH
EB2400000 CE30839 RICHLAND OPER OFFICE MALTZ MILL PA MSW PROJECT	001	1,000	1,000	0	0	RLO	WALTER D
EB2400000 CE30845 ARHCO WA04 RICHLAND OPER OFFICE MED BTU GASIFICATION RFP (-500 RGH)	001	3,000	150	4,500	0	RLO	FRIEDRICH
EB2400000 OR20837 ZZOTH VG10 SAI BIOMASS (SRHC) SUPPORT	.001	190	190	190	0	ORO	SPRAGUE S
EB2400000 CH10093 GOL CO05 SOLAR ENERGY RESEARCH AQUATIC SPECIES	003	2,300	2,300	1,735	1,200	CHO	SPRAGUE S

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EB24:ACTIVITY NAME: BIOMASS AND ALCOHOL

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2400000 CH10093 GOL C005 SOLAR ENERGY RESEARCH BIOFUELS - PLANNING SUPPORT	005	300	300	0	0	CHO	BERGER B
EB2400000 CH10093 GOL C005 SOLAR ENERGY RESEARCH ANAEROBIC DIGESTION	009	400	400	0	0	CHO	FRIEDRICH
EB2400000 CH10093 GOL C005 SOLAR ENERGY RESEARCH AQUATIC SUBCONTRACT-HBCU	312	150	150	150	0	CHO	SPRAGUE S
EB2400000 CH10093 GOL C005 SOLAR ENERGY RESEARCH ALCOHOL FUELS-BIOCHEM CONV (-200 GRH)	430	3,800	3,800	4,340	3,760	CHO	MOORER R
EB2400000 CH10093 GOL C005 SOLAR ENERGY RESEARCH EMH BIOCHEM RESEARCH	711	100	100	1,630	2,800	CHO	LAILAS N

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EB24:ACTIVITY NAME: BIOMASS AND ALCOHOL

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2400000 CE30792 ZZOTH AB05 TENNESSEE VALLEY AUTH REGIONAL BIOMASS PROGRAM(S.E.)	001	1,000	1,000	528	0	WHQ	O'CONNELL
EB2400000 CS80010 ZZOTH AB05 TENNESSEE VALLEY AUTH LIGNOCELLULOSIC FEEDSTK TESTING	005	290	290	290	0	WHQ	MOORER R
EB2400000 CS20038 ZZOTH IL05 WASTE MANAGEMENT INC REFUSE TO METHANE CONVERSION	001	500	500	500	0	CHO	LAILAS N
EB24 ACTIVITY TOTAL		30,161	26,762	24,805	15,115		

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EC04:ACTIVITY NAME: URBAN WASTE

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EC0400000 CHEN038 ARG IL13 ARGONNE NATIONAL LAB ENERGY FROM URBAN WASTE RD&D	308	403	403	0	0	CHO	WALTER D
EC0400000 CE30842 WAS DI98 DOE ADMINISTRATIVE SERVICES PRINTING-LANDFILL GAS STUDY	001	0	0	0	0	WHQ	WALTER D
EC0400000 CE30941 WAS DI98 DOE ADMINISTRATIVE SERVICES PRINTING-LARGE SCALE COMMERCIAL COMB. R	001	1	1	0	0	WHQ	WALTER D
EC0400000 ID01570 INEL ID02 IDAHO NATL ENGNG LAB URBAN WASTE BIOCHEM/TECH RES	117	275	275	0	0	IDO	KOUTS C
EC0400000 CE30782 ZZOTH PA13 KEM-SOLV PYROLYSIS OF MSW IN COKE OVENS	001	0	0	0	0	WHQ	KOUTS C

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EC04:ACTIVITY NAME: URBAN WASTE

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EC0400000 NATIONAL BUREAU STANDARD ORGANIC EMISSIONS RESEARCH	CE30834	WAS	DI98	037	125	125	0	0	WHQ	KOUTS C
EC0400000 NATIONAL BUREAU STANDARD ORG CHLORINE FORM/DESTRUCT	CE30835	WAS	DI98	046	220	220	0	0	WHQ	KOUTS C
EC0400000 NATIONAL CENTER FOR RESOURCE RECOVE RESOURCE RECOVERY RESEARCH	CS24315		CA	314	23	23	0	0	SFO	KOUTS C
EC0400000 PSE & G RESEARCH CORP SEWAGE SLUDGE AS A SUPPLEMENTARY BOILER	CS20061	ZZOTH	NJ10	001	0	0	0	0	WHQ	KOUTS C
EC04 ACTIVITY TOTAL					1,047	1,047	0	0		

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35EB:ACTIVITY NAME: SOLAR ENERGY

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
35EB24000 CHENG38 ARG IL13 ARGONNE NATIONAL LAB MUNICIPAL SOLID WASTE CAP EQ	012	25	25	0	0	CHO	WALTER D
35EB24000 TBD0000 WAS DI98 INTERNATIONAL BUS MACH MICROCOMPUTER EQ	007	37	37	0	0	WHQ	BERGER B
35EB24000 OR21400 OAKR TN03 OAK RIDGE NATIONAL LAB SRIC-CAPITAL EQ	007	100	100	0	0	ORO	SPRAGUE S
35EB24000 CH10093 GOL CO05 SOLAR ENERGY RESEARCH AQUATICS/ALCOHOL FUELS CAP EQ(-24 GRH)	002	835	835	476	465	CHO	BERGER B
35EB ACTIVITY TOTAL		997	997	476	465		
DIVISION TOTAL		32,205	28,806	25,281	13,580		

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AM05:ACTIVITY NAME: GEOPRESSURED RESOURCES

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM0505000 NV00020 HOLMES & NARVER INC GEOPRESS PROG COORD & SUPPORT	008	81	81	0	0	NVO	LOMBARD D
AM0510000 NV00038 FENIX & SCISSION INC BRAZORIA CO WELL	002	1,471	1,471	0	0	NVO	LOMBARD D
AM0510000 TBD0000 IDAHO OPER OFFICE GEOPRES WELL TEST	601	200	200	3,799	2,530	IDO	LOMBARD D
AM0510000 SF00098 LAWRENCE BERKELEY LAB LIQUID HYDROCARBON/GEOPRESS GAS	110	50	50	0	0	SFO	LOMBARD D
AM0510000 CE30784 MERIDIAN CORP RE SUPPORT SVC(GEOTH-HYDRO)	019	258	258	361	0	HHQ	LOOSE R

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AM05:ACTIVITY NAME: GEOPRESSURED RESOURCES

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM0510000 TBD0000 NEVADA OPER OFFICE UNIV & INDUSTRIAL PROJECTS	010	453	453	0	0	NVO	LOMBARD D
AM0510000 TBD0000 TBD MGMT SAVINGS	008	90	90	100	0	NHQ	MOCK J
AM0510000 ET27217 TECHNADRIL/F&S DESIGN GEOP WELL(GLADYS MCCALL)	001	1,839	1,839	0	0	NVO	LOMBARD D
AM0510000 ET27112 TEXAS UNIV AT AUSTIN COORDINATION ASSISTANCE	013	487	487	0	0	NVO	LOMBARD D
AM0520000 NV10174 LOUISIANA STATE UNIV LA WELL SITE MONITOR	011	324	324	0	0	NVO	LOMBARD D

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AM05:ACTIVITY NAME: GEOPRESSURED RESOURCES

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM0520000 OR21400 OAK RIDGE NATIONAL LAB ENVIRONMENTAL ASSESSMENTS	015	50	50	20	0	ORO	BRESEE J
AM05 ACTIVITY TOTAL		5,303	5,303	4,280	2,530		

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AM10:ACTIVITY NAME: GEOTHERMAL TECHNOLOGY DEVELOPMENT

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1005150 CE30784 ZZOTH VG10 MERIDIAN CORP RE SUPPORT SERVICE (GEOTH & HYDRO)	009	451	451	0	0	WHQ	LOOSE R
AM1005150 DP00789 ALBU NM01 SANDIA LIVERMORE LABORAT PERMEABILITY ENHANCEMENT	038	650	650	500	0	ALO	REED M
AM1010100 ALENG36 LOS NM03 LOS ALAMOS SCIENTIFIC LAB FENTON HILL SITE SUPPORT (-294 GRH)	045	450	450	3,406	4,550	ALO	RANNELS J
AM1010100 ALENG36 LOS NM03 LOS ALAMOS SCIENTIFIC LAB ANALYTICAL & LAB SUPPORT	046	900	900	2,922	0	ALO	RANNELS J
AM1010100 ALENG36 LOS NM03 LOS ALAMOS SCIENTIFIC LAB MATLS-EQMT-INSTR R&D	047	750	750	0	0	ALO	RANNELS J

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AM10:ACTIVITY NAME: GEOTHERMAL TECHNOLOGY DEVELOPMENT

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1010100 LOS ALAMOS SCIENTIFIC LAB PHASE II RESERV EST-FENTON HILL	ALENG36	LOS	NM03	052	6,700	6,700	0	0	ALO	RANNELS J
AM1010100 LOS ALAMOS SCIENTIFIC LAB HDR TECH LIBRARY	ALENG36	LOS	NM03	083	75	75	0	0	ALO	RANNELS J
AM1010100 LOS ALAMOS SCIENTIFIC LAB ROCK MECH DETROLOGY	ALENG36	LOS	NM03	089	125	125	0	0	ALO	RANNELS J
AM1010150 LOS ALAMOS SCIENTIFIC LAB HDR	ALENG36	LOS	NM03	048	100	100	0	0	ALO	RANNELS J
AM1015050 ARGONNE NATIONAL LAB CHEM TREATMENT OF SPENT BRINE	CHENG38	ARG	IL13	049	33CR	33CR	0	0	CHO	HOOPER G

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AM10:ACTIVITY NAME: GEOTHERMAL TECHNOLOGY DEVELOPMENT

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AM1015050 MA32625 WAS DI98 CALCULON DISPLAY WRITER/PC SUPPORT	001	2	2	0	0	WHQ	BACK P
AM1015050 SF11563 SAND CA01 CALIFORNIA UNIV OF MODEL FOR DEP PREDICTION	004	143	143	0	0	SFO	HOOPER G
AM1015050 ID01570 IDA ID02 IDAHO NATL ENGNG LAB BRINE INJECTION DATA ANAL & TECH ASSMT	126	500	500	0	0	IDO	REED M
AM1015050 SF00098 BERK CA01 LAWRENCE BERKELEY LAB RESERVOIR MODELING	104	300	300	250	273	SFO	REED M
AM1015050 SFENG48 LIV CA09 LAWRENCE LIVERMORE LAB INJECTION MODELING	035	100	100	100	91	SFO	REED M

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AM1015050 RL01830 RICH WA04 PACIFIC NORTHWEST LAB CHEM. ANALYSIS OF BRINE	045	50	50	50	0	RLO	HOOPER G
AM1015050 TBD0000 ZZOTH CA11 STANFORD UNIVERSITY TRACER TECHNIQUES	009	200	200	150	0	IDO	REED M
AM1015050 TBD0000 TBD INJECTION FIELD TESTING (EAST MESA)	001	40	40	341	728	SFO	REED M
AM1015050 TBD0000 SLC UT03 UNIV OF UTAH RES INST TRACER ANALYSIS	038	200	200	150	0	IDO	REED M
AM1015100 TBD0000 TUC AN02 ARIZONA UNIV OF DATING OF VOLCANIC ROCKS	009	30	30	0	0	IDO	REED M

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AM10:ACTIVITY NAME: GEOTHERMAL TECHNOLOGY DEBELOPMENT

B&R NO., CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1015100 ID01570 IDA ID02 IDAHO NTL ENGNG LAB TECH ASSIST & MONITOR-WEST RESERVOIR ST	129	50	50	0	0	IDO	REED M
AM1015100 TBD0000 IDA ID02 IDAHO OPER OFFICE CASCADES MEASUREMENT	007	375	375	250	0	IDO	REED M
AM1015100 TBD0000 IDA ID02 IDAHO OPER OFFICE COST SHARED CASCADES CHARACTERIZATION (	009	1,000	1,000	444	819	IDO	REED M
AM1015100 SF00098 BERK CA08 LAWRENCE BERKELEY LAB RESERVOIR CHARACTERIZATION (VSP)	105	600	600	600	0	SFO	REED M
AM1015100 SF00098 BERK CA08 LAWRENCE BERKELEY LAB RESERVOIR DEF. PROGRAM MGT	107	200	200	200	0	SFO	REED M

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AM10:ACTIVITY NAME: GEOTHERMAL TECHNOLOGY DEBELOPMENT

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AM1015100 SF00098 BERK CA08 LAWRENCE BERKELEY LAB US-MEX RES DEF AGREEMENT	117	100	100	0	0	SFO	REED M
AM1015100 SFEN048 LAWRENCE LIVERMORE LAB			13			SFO	
AM1015100 TBD0000 ZZOTH OR99 OREGON-DOGAMI NEWBERRY CALDERA TESTING	004	160	160	100	0	IDO	REED M
AM1015100 CE77022 WAS DI98 SMITHSONIAN INSTITUTION VOLCANO BIBLIOG. EXPANSION	001	10	10	0	0	WHQ	REED M
AM1015100 TBD0000 ZZOTH TX99 SOUTHERN METHODIST UNIV GEOTHERMAL MAP	001	42	42	0	0	IDO	REED M

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AM10:ACTIVITY NAME: GEOTHERMAL TECHNOLOGY DEBELOPMENT

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1015100 SF11459 STAN CA11 STANFORD UNIV HEAT EXTRACTION RESEARCH	010	340	340	400	0	SFO	REED M
AM1015100 SF11459 STAN CA11 STANFORD UNIV RESOURCE DEFINITION WORKSHOP	012	42	42	0	0	SFO	REED M
AM1015100 RA50294 ZZOTH VG10 U.S. GEOLOGICAL SURVEY CASCADE RESERVOIR DEFINITION	056	200	200	255	0	WHQ	REED M
AM1015100 TBD0000 SLC UT03 UNIV OF UTAH FRACTURE MAPPING - ELECT TECH	036	200	200	300	0	SFO	REED M
AM1015100 TBD0000 UNIV OF UTAH GEOLOGIC MODELS OF FRACT RESOURCES	041	60	60	0	0	SFO	REED M

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B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK E&EM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1015100 TBD0000 SLC UT03 UTAH UNIV OF TECH ASSIST & MONITOR-WEST RESERVOIR ST	042	50	50	0	0	IDO	REED M
AM1015100 TBD0000 SLC UT03 UTAH UNIV OF RESISTIVITY EXPLORATION TECH	043	50	50	0	0	IDO	REED M
AM1015100 TBD0000 SLC UT03 UTAH UNIV OF US-MEX RES DEF AGREEMENT	044	50	50	0	0	IDO	REED M
AM1015150 TBD0000 PRO RI01 BROWN UNIV TWO PHASE FLOW RESEARCH	003	130	130	0	0	SFO	LASALA R
AM1015150 ID01570 IDA ID02 IDAHO NTL ENGNG LAB BINARY CYCLE TECH	001	800	800	630	360	IDO	LASALA R

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AM10:ACTIVITY NAME: GEOTHERMAL TECHNOLOGY DEVELOPMENT

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1015150 ID01570 IDA ID02 IDAHO NTL ENGNG LAB NCA&T HEAT EXCH DATA ANALYSIS	127	65	65	50	0	IDO	LASALA R
AM1015150 ALENG36 LOS NM03 LOS ALAMOS NATIONAL LAB DOWNHOLE PUMPS	078	283	283	0	0	ALO	LASALA R
AM1015150 SF10794 OAKL CA08 WESTEC SERVICES INC BASELINE OPS/OUTSIDE EXP	014	207	207	200	0	SFO	LASALA R
AM1015150 SF10794 OAKL CA08 WESTEC SERVICES INC GEOTH TEST FACILITY-MAJOR REPAIRS	015	125	125	0	0	SFO	LASALA R
AM1020000 CH00016 UPT NO01 BROOKHAVEN NATIONAL LAB MTLS FOR DYNAMIC SEALS (LGARDE)	049	200	200	0	0	CHO	LASALA R

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AM10:ACTIVITY NAME: GEOTHERMAL TECHNOLOGY DEVELOPMENT

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AM1020000 ALENG36 ALBU NM03 LOS ALAMOS NATIONAL LAB HIGH TEMP GEOTH CEMENT TEST	077	50	50	0	0	ALO	ALLEN A
AM1020000 CE77015 MINES BUREAU OF NATL ROCK MECHANIC COMMITTEE	001	0	0	0	0	WHQ	REED M
AM1020000 CE77023 WAS DI98 MINES BUREAU OF NATL ROCK MECHANIC COMMITTEE	001	10	10	0	0	WHQ	REED M
AM1020000 DP00789 ALBU NM03 SANDIA LIVERMORE LABORAT HARD ROCK PENETRATION	001	550	550	1,975	0	ALO	LASALA R
AM1020000 DP00789 ALBU NM03 SANDIA LIVERMORE LABORAT CONCEPT DESIGN FOR MELT & VAPORIZE	002	700	700	575	0	ALO	LASALA R

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AM10:ACTIVITY NAME: GEOTHERMAL TECHNOLOGY DEVELOPMENT

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE	CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1020000	DP00789	ALBU	NM	03							
SANDIA LIVERMORE LABORAT											
LAB MEAS OF ROCK PENET PARAMETERS					003	600	600	513	0	ALO	ALLEN A
AM1020000	DP00789	ALBU	NM	03							
SANDIA LIVERMORE LABORAT											
IMPROVING BOREHOLE MAPPING					004	400	400	400	0	ALO	ALLEN A
AM1020000	DP00789	ALBU	NM	03							
SANDIA LIVERMORE LABORAT											
EVAL INSTR FOR MEAS DOWNHOLE PARAMETERS					005	600	600	0	0	ALO	ALLEN A
AM1020000	DP00789	ALBU	NM	03							
SANDIA LIVERMORE LABORAT											
INDUSTRY COOP DRILLING SYS (-85 GRH)					058	1,000	1,000	415	400	ALO	TOMS R
AM1020000	DP00789	ALBU	NM	03							
SANDIA LIVERMORE LABORAT											
HARD ROCK PENETRATION PROG MGT					064	115	115	0	1,479	ALO	TOMS R

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AM10:ACTIVITY NAME: GEOTHERMAL TECHNOLOGY DEVELOPMENT

B&R NO. CONTRACT NO. CITY STATE CONG. CONTRACTOR NAME DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1025000 DP00789 SANDIA LIVERMORE LABORAT MAGMA-MATERIAL REQMTS & TESTING	001	448	448	0	0	ALO	ALLEN A
AM1025000 DP00789 SANDIA LIVERMORE LABORAT EXPLOR TECH & SITE SELECTION	002	265	265	0	0	ALO	ALLEN A
AM1025000 DP00789 SANDIA LIVERMORE LABORAT MAGMA SYS CONCEPTS & ECONOMICS	003	85	85	0	0	ALO	ALLEN A
AM1025000 DP00789 ALBU NM03 SANDIA LIVERMORE LABORAT MAGMA EXTRACT CONCEPTS & LAB TESTS	004	1,348	550	1,233	910	ALO	REED M
AM1030000 TBD0000 OAKL CA08 SAN FRANCISCO OPERATIONS OFF SCIENTIFIC DEEP DRILLING- S. SEA(-67 GR	001	997	997	728	0	SFO	TOMS R

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AM10:ACTIVITY NAME: GEOTHERMAL TECHNOLOGY DEVELOPMENT

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1035000 BROOKHAVEN NATIONAL LAB NON METALLIC MATERIAL DEV	CH00016	UPT	NO01	047	450	450	250	0	CHO	LEHR L
AM1035000 BROOKHAVEN NATIONAL LAB TOXIC WASTE RECOVERY	CH00016	UPT	NO01	048	250	250	100	270	CHO	HOOPER G
AM1035000 PACIFIC NORTHWEST LAB MONITOR INST/CO2/PH PROBE	RL01830	RICH	WA04	042	185	185	237	0	RLO	HOOPER G
AM1035000 PACIFIC NORTHWEST LAB PARTICLE METERS	RL01830	RICH	WA04	043	275	275	150	246	RLO	HOOPER G
AM1050000 DOE ADMIN SERVICES PRINTING CHARGE-PROGRAM REVIEW	CE77024	WAS	DI98	001	4	4	0	0	WHQ	BURR R

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AM10:ACTIVITY NAME: GEOTHERMAL TECHNOLOGY DEVELOPMENT

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME DESCRIPTION OF WORK CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1050000 CE77021 WAS DI98 DOE ADMINISTRATIVE SERVICES PRINTING CHARGE-TECH TR WORKSHOP	001	3	3	0	0	WHQ	BURR R
AM1050000 CE77025 IDA ID02 DOE ADMINISTRATIVE SERVICES PRINT GEO REPT	001	1	1	0	0	WHQ	BURR R
AM1050000 ID01570, IDAHO NTL ENGNG LAB GEOTHERMAL TECH TRANSFER	129	250	250	0	0	IDO	FLYNN J
AM1050000 ID01570 IDA ID02 IDAHO NTL ENGNG LAB GEOTHERMAL PUBLICATIONS	130	36	36	0	0	IDO	FLYNN J
AM1050000 TBD0000 WAS DI98 LOS ALAMOS NATIONAL LAB HDR PROG SUPPORT	001	58	58	0	0	WHQ	FLYNN J

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AM10:ACTIVITY NAME: GEOTHERMAL TECHNOLOGY DEVELOPMENT

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1050000 TBD0000 OAKL CA08 SAN FRANCISCO OPER OFC GEOTHERMAL TECHNOLOGY TRANSFER	115	471	471	0	0	SFO	BURR R
AM10 ACTIVITY TOTAL		26,223	25,438	17,874	10,126		

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AM15:ACTIVITY NAME: HYDROTHERMAL INDUSTRIALIZATION

B&R NO. / CONTRACT NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CITY	STATE	CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1500000 OR20837 SCIENCE APPLICATIONS RENEWABLE ENERGY TECH ASSESSMENT	OAKR		TN03	001	100	100	0	0	ORO	MOORE G
AM1510000 TBD0000 ALASKA DIV OF GEOL & GEOPHY SURVEY STATE RES ASSMT & EVAL	ZZOTH	AK99		002	30	30	0	0	IDO	REED M
AM1510000 TBD0000 ALASKA STATE OF GEOTHERMAL STATE ASSESSMENT				003	80	30	0	0	IDO	REED M
AM1510000 TBD0000 CALIFORNIA DIV OF MINE & GEOL RESOURCE ASSESS - ST OF CA DEOBLIG				007	0	0	0	0	SFO	REED M
AM1510000 TBD0000 HAWAII UNIV OF STATE RES EVAL & ASSMT	ZZOTH	HI99		007	100	100	100	0	SFO	REED M

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AM15:ACTIVITY NAME: HYDROTHERMAL ENERGY RESOURCES

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1510000 ID01570 IDA ID02 IDAHO NTL ENGNG LAB STATE TEAM TECH ASST	128	50	50	0	0	IDO	REED M
AM1510000 ID01570 IDA ID02 IDAHO NTL ENGNG LAB GEO DIR HEAT ACTS	129	47	47	0	0	IDO	PRATSCH L
AM1510000 TBD0000 IDA ID02 IDAHO, STATE OF GEOTHERMAL STATE ASSESSMENT	003	30	30	0	0	IDO	REED M
AM1510000 CE30784 ZZOTH VG10 MERIDIAN CORP RE SUPPORT SVC(GEOTH-HYDRO)	022	22	22	113	0	HHQ	LOOSE R
AM1510000 TBD0000 ZZOTH NM99 NEW MEXICO STATE OF GEOTHERMAL STATE ASSESSMENT	005	10	10	0	0	IDO	REED M

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AM15:ACTIVITY NAME: HYDROTHERMAL ENERGY RESOURCES

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1510000 ID12490 NEW YORK STATE ENER OF STUDY OF EASTERN GEOTHERMAL WELLS	001	65	65	1,060	0	IDO	PRATSCH L
AM1510000 TBD0000 ZZOTH ND99 NORTH DAKOTA UNIV OF STATE RES ASSMT & EVAL	001	50	50	0	0	IDO	REED M
AM1510000 TBD0000 ZZOTH OR99 OREGON INST OF TECH GEOTH STATE TEAM ASST. (-75 GRH)	020	150	150	0	0	IDO	PRATSCH L
AM1510000 TBD0000 ZZOTH SD99 SOUTH DAKOTA OFFICE OF ENERGY HEAT PUMP APPLIC IN LOW TEMP SITES	001	20	20	0	0	IDO	REED M
AM1510000 TBD0000 SLC UT03 UNIV OF UTAH RES INST STATE TEAM TECH SUPPORT	039	100	100	0	0	IDO	REED M

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AM15:ACTIVITY NAME: HYDROTHERMAL ENERGY RESOURCES

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1510000 TBD0000 SLC UT03 UNIV OF UTAH RES INST ASCENSION ISLAND INTERPRETATION	040	50	50	0	0	IDO	REED M
AM1510000 TBD0000 SLC UT99 UTAH STATE OF GEOTHERMAL STATE ASSESSMENT	004	50	50	0	0	IDO	REED M
AM1510000 TBD0000 ZZOTH WA99 WASHINGTON STATE OF TECH ASSIST ACTS	005	49	49	0	0	IDO	REED M
AM1510000 TBD0000 ZZOTH WY99 WYOMING GEOL. SURVEY STATE RES ASSMT & EVAL	001	50	50	0	0	IDO	REED M
AM1525100 TBD0000 TBD WITHDRAW HEBER R&D FUNDS	001	31CR	31CR	0	0	SFO	PRATSCH L
AM15 ACTIVITY TOTAL		1,022	972	1,273	0		

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AM18:ACTIVITY NAME: HYDROTHERMAL COMMERCIALIZATION

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AM1800000 CE77027 WAS DI98 DOE ADMINISTRATIVE SERVICES HELICAL SCREW EXPANDER REPORT	001	2	2	0	0	WHQ	LASALA R
AM1820000 ET27240 IBS COST OVERRUN DUE TO AUDIT	001	5	5	0	0	WHQ	HOOPER G
AM18 ACTIVITY TOTAL		7	7	0	0		

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CC10:ACTIVITY NAME: GEOTHERMAL RESOURCES DEVELOPMENT FUND(GRDF)

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
CC1000000 TBD0000 SAN FRANCISCO OPER OFC FY 1984 UNOBLIGATED BAL-GRDF	026	5,975	5,975	0	0	SFO	LABRIE P
CC10 ACTIVITY TOTAL		5,975	5,975	0	0		

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35AM:ACTIVITY NAME: CAPITAL EQUIPMENT

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
35AM10000 CH00016 UPT NO01 BROOKHAVEN NATIONAL LAB GEOTH MATERIAL DEV CAP EQ	052	15	15	25	0	CHO	LASALA R
35AM10000 ID01570 IDA ID02 IDAHO NTL ENGNG LAB HEAT CYC CAPITAL EQ	006	50	50	40	0	IDO	LASALA R
35AM10000 YBD0000 WAS DI98 INTERNATIONAL BUS MACH HORD PROC & MICRO COMP EQ (-19 GRH)	011	50	50	6	0	WHQ	MOCK J
35AM10000 SF00098 BERK CA08 LAWRENCE BERKELEY LAB RESERVOIR DEF CAPITAL EQ	109	85	85	100	0	SFO	REED M
35AM10000 RL01830 RICH WA04 PACIFIC NORTHWEST LABS GEOCHEM DATA ACQUISTION EQ	047	25	25	25	0	RLO	HOOPER G

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35AM:ACTIVITY NAME: CAPITAL EQUIPMENT

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
35AM10000 DP80789 ALBU NM03 SANDIA LIVERMORE LABORAT HARD ROCK PENETRATION SUPPORT EQ	060	175	175	150	175	ALO	LASALA R
35AM ACTIVITY TOTAL		400	400	346	175		
DIVISION TOTAL		38,930	38,095	23,773	12,831		

AK04:ACTIVITY NAME: ELECTRIC FIELD EFFECTS RES

B&R NO. CONTRACT NO. CONTRACTOR NAME DESCRIPTION OF WORK	CITY	STATE CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0400000 CE76007 AEROSPACE CORPORATION TECH. SUPPORT IN ELECTRIC FIELDS EFFECT			001	0	0	0	0	WHQ	KLEIN K
AK0400000 CHENG38 ARGONNE NATIONAL LAB CIRCADIAN PHASE SHIFT RESEARCH	ARG	IL13	001	300	300	300	300	CHO	KLEIN K
AK0400000 RA50153 GENERAL ELECTRIC CO HVDC ION RESEARCH	PITTS	MA01	001	303	303	300	300	CHO	KLEIN K
AK0400000 CE76260 JERRY L PETTIS BIOLOGICAL RESEARCH	LOM	CA37	001	0	0	0	0	WHQ	KLEIN K
AK0400000 CE76246 MIDWEST RESEARCH INSTITUTE IMMUNOLOGICAL AND BIO. EFFECTS OF 60 HZ	KAN	MO06	001	654	654	300	300	WHQ	KLEIN K

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AK04:ACTIVITY NAME: ELECTRIC FIELD EFFECTS RES

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0400000 CE76201 WAS DI98 NATIONAL BUREAU STANDARD SUPPORT OF RESEARCH PROJECTS	001	293	293	410	400	WHQ	KLEIN K
AK0400000 ORENG26 OAKR TN03 OAK RIDGE NATIONAL LAB HUMAN RISK	001	300	300	320	200	ORO	KLEIN K
AK0400000 ORENG26 OAKR TN03 OAK RIDGE NATIONAL LAB EMP CONSULTANTS/WORKSHOP	002	35	35	0	0	ORO	KLEIN K
AK0400000 RL01830 RICH WA04 PACIFIC NORTHWEST LABS BIOLOGICAL EFFECTS OF ELECTRIC FIELDS	001	1,710	1,710	0	625	RLO	KLEIN K
AK0400000 ET29078 LOM CA37 PETTIS MEMORIAL VA HOSPITAL BIOLOGICAL RESEARCH-ELECTRIC FIELDS	001	325	325	0	0	WHQ	KLEIN K

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AK04:ACTIVITY NAME: ELECTRIC FIELD EFFECTS RES

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0400000	CE76263	ZZOTH	ZZ01							
RFP										
ELECTRIC/MAGNETIC FIELD EFFECTS ON HUMA				001	0	0	0	0	WHQ	KLEIN K
AK0400000	CE76264	ZZOTH	ZZ01							
RFP										
HUMAN PERCEPTION RESEARCH				001	0	0	0	0	WHQ	KLEIN K
AK0400000	CE76254	ROC	NO32							
ROCHESTER UNIVERSITY OF										
BIOLOGICAL RESEARCH				001	334	334	307	300	CHO	KLEIN K
AK0400000	EV03490									
ROCHESTER UNIVERSITY OF										
BIOLOGICAL RESEARCH				001	86	86	0	0	CHO	KLEIN K
AK0400000	CE76253	ZZOTH	ZZ01							
H L & ASSOCIATES										
ELECTRIC FIELD EFFECTS RESEARCH PROGRAM				001	340	340	30	0	WHQ	KLEIN K
AK04 ACTIVITY TOTAL					4,680	4,680	1,967	2,425		

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AK05:ACTIVITY NAME: RELIABILITY RESEARCH

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO. / CITY / CONG.	STATE	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0500000	CE90143	FTB VA08							
ARMY DEPT OF									
TECHNICAL & ADMINISTRATIVE SUPPORT			001	50	50	0	0	WHQ	BROGAN J
AK0500000	RA50156	NEBR NJ07							
CABLE TECH LAB INC									
HIGH VOLTAGE INSULATING SYSTEMS			001	150	150	0	0	CHO	EATON R
AK0500000	CE10506								
FOUR PHASE SYSTEMS									
RENEW LEASE & MAINTENANCE OF FOUR PHASE			001	3	3	0	0	WHQ	HILL M
AK0500000	CE10507								
FOUR PHASE SYSTEMS									
LEASE & MAINTENANCE FOUR PHASE EQUIP.			001	1	1	0	0	WHQ	HILL M
AK0500000	CE76249	SCHE NO01							
GENERAL ELECTRIC CO									
ON-LINE DETECTION OF SYSTEM INSTABILITI			001	125	125	200	200	WHQ	ROESLER D

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AK05:ACTIVITY NAME: RELIABILITY RESEARCH

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE	CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0500000 MASSACHUSETTS INST TECH HOMEOSTATIC	RA50649	CAM	MA	08	001	46	46	0	0	WHQ	ROESLER D
AK0500000 NASA COMMUNICATIONS & CONTROL	ET29372	OAKR	TN	03	001	400	400	0	0	ORO	ROESLER D
AK0500000 NATIONAL BUREAU STANDARD SUPPORT OF RESEARCH PROJECTS	CE76201	WAS	DI	98	001	157	154	0	0	WHQ	KLEIN K
AK0500000 OAK RIDGE NATIONAL LAB ELECTROMAGNETIC PULSE	ORENG26	OAKR	TN	03	003	2,233	2,233	1,627	1,000	ORO	KLEIN K
AK0500000 OAK RIDGE NATIONAL LAB HARMONICS SEMINARS	ORENG26	OAKR	TN	03	006	100	100	0	0	ORO	KLEIN K

AK05:ACTIVITY NAME: RELIABILITY RESEARCH

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0500000 OAK RIDGE NATIONAL LAB	ORENG26	OAKR	TN03							
				007	450	450	0	0	ORO	KLEIN K
AK0500000 OAK PIDGE NATIONAL LAB CONSULTANTS/UTN	ORENG26	OAKR	TN03	008	50	50	0	0	ORO	KLEIN K
AK0500000 SANDIA NATIONAL LAB POWER CONDITIONING	DP00789	ALBU	NM02	001	150	150	0	0	ALO	ROESLER D
AK0500000 SCIENTIFIC SYSTEMS PLANT CONTROL	ET29328	CAM	MA08	001	1	1	0	0	WHQ	ROESLER D
AK0500000 SYSTEMS SCIENCES INC RATE ADJUSTMENTS	ET29366			001	1	1	0	0	WHQ	ROESLER D

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AK05:ACTIVITY NAME: RELIABILITY RESEARCH

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0500000 CE76259 ZZOTH ZZ01 TBD POSTURING AND RESTORATION ASSESSMENT	001	99	99	100	0	SFO	ROESLER D
AK0500000 CE76239 BLA VA06 VIRGINIA POLYTECHNIC INST REAL TIME MEASUREMENT IN POWER SYS.	001	158	158	0	0	WHQ	ROESLER D
AK0500000 CE76258 STL M001 WASHINGTON UNIV OF ON-LINE DETECTION OF SYSTEMS INSTABILIT	001	175	175	245	0	WHQ	ROESLER D
AK05 ACTIVITY TOTAL		4,349	4,346	2,172	1,200		

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AK06:ACTIVITY NAME: SYSTEMS TECHNOLOGY

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0600000 CE90230 WAS DI98 AIR FORCE DEPT OF TECHNOLOGY MGMT AND ASSESSMENT	001	0	0	0	0	WHQ	LEVINSON T
AK0600000 CS35217 WAS DI98 AIR FORCE DEPT OF TECH MANAGEMENT ASSESSMENT	001	0	0	0	0	WHQ	LEVINSON T
AK0600000 CH00016 BRO NO01 BROOKHAVEN NATIONAL LAB AC SUPERCONDUCTING POWER CABLE RESEARCH	001	1,650	1,650	425	1,000	CHO	EATON R
AK0600000 ET29040 DOE ADMINISTRATIVE SERVICE COORDINATED DEC. EMERGENCY CONTROL	001	1	1	0	0	WHQ	ROESLER D
AK0600000 CE76261 WAS DI98 DOE ADMINISTRATIVE SERVICES REPORT FOR SYSTEMS RESEARCH	001	2	2	0	0	WHQ	ROESLER D

AK06:ACTIVITY NAME: SYSTEMS TECHNOLOGY

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0600000	CE76248	MTVW	CA12							
ELECTROTECK INC										
PROVIDE TECHNICAL & ANALYTICAL SUPPORT				001	355	355	0	0	WHQ	ROESLER D
AK0600000	CE76245	COLA	MD06							
ENERGETIC, INC										
SUPPORT SERVICES				001	251	251	0	0	WHQ	KLEIN K
AK0600000	CE76214	HON	HI02							
HAWAII ELECTRIC CO										
HAWAII DEEP WATER CABLE (HDWC) PROGRAM				001	320	320	0	0	CHO	EATON R
AK0600000	CE76256	WAS	DI98							
HOWARD UNIV										
LABORATORY IMPROVEMENT & RESEARCH PROGR				001	136	136	0	0	WHQ	ROESLER D
AK0600000	ALENG36	LOS	NM03							
LOS ALAMOS SCIENTIFIC LAB										
EMP SURVIVABILIGY ASSESSMENT				002	50	50	0	0	ALO	BROGAN J

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AK06:ACTIVITY NAME: SYSTEMS TECHNOLOGY

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0600000 MASSACHUSETTS INST TECH ADVANCED SUPERCOND GEN	CE76251	CAM	MA08	001	700	700	400	400	WHQ	EATON R
AK0600000 NASA OPTICAL FIBER RESEARCH	ET29372	OAKR	TN03	001	200	200	300	100	ORO	ROESLER D
AK0600000 NATIONAL ACADEMY OF SCIENCE PROGRAM PLANNING AND ANALYSIS	CE90142	WAS	DI98	001	25	25	0	0	WHQ	LEVINSON T
AK0600000 NATIONAL BUREAU STANDARD SUPPORT OF RESEARCH PROJECTS	CE76201	WAS	DI01	001	300	300	140	300	WHQ	KLEIN K
AK0600000 OAK RIDGE NATIONAL LAB METAL OXIDE VARISTOR-MGM SUPPORT	ORENG26	OAKR	TN03	001	4,610	50	360	0	ORO	EATON R

AK06:ACTIVITY NAME: SYSTEMS TECHNOLOGY

B&R NO. / CONTRACT NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0600000 ORENG26 OAK RIDGE NATIONAL LAB TECHNICAL CONCEPTS & MANAGEMENT	OAKR	TN03	002	515	515	305	375	ORO	EATON
AK0600000 ORENG26 OAK RIDGE NATIONAL LAB DIELECTRIC RESEARCH	OAKR	TN03	003	275	275	100	400	ORO	EATON R
AK0600000 ORENG26 OAK RIDGE NATIONAL LAB HIGH VOLTAGE DIRECT CURRENT	OAKR	TN03	004	780	780	0	0	ORO	ROESLER D
AK0600000 ORENG26 OAK RIDGE NATIONAL LAB AUTOMATION INVESTIGATION	OAKR	TN03	005	1,345	1,345	600	0	ORO	ROESLER D
AK0600000 ORENG26 OAK RIDGE NATIONAL LAB HIGHER PHASE ORDER TRANSMISSION	OAKR	TN03	006	325	325	0	0	ORO	KLEIN K

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AK06:ACTIVITY NAME: SYSTEMS TECHNOLOGY

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0600000 ORENG26 OAKR TN03 OAK RIDGE NATIONAL LAB ADVANCED DIELECTRICS	007	925	925	0	0	ORO	KLEIN K
AK0600000 ORENG26 OAKR TN03 OAK RIDGE NATIONAL LAB POLYMERIC MATERIALS	008	250	250	0	0	ORO	EATON R
AK0600000 ORENG26 OAKR TN03 OAK RIDGE NATIONAL LAB AMORPHOUS METALS	009	150	150	0	0	ORO	EATON R
AK0600000 ORENG26 OAKR TN03 OAK RIDGE NATIONAL LAB GASEOUS DIELECTRICS	010	20	20	0	0	ORO	EATON R
AK0600000 ORENG26 OAKR TN03 OAK RIDGE NATIONAL LAB AGING PHENOMENA	011	150	150	0	0	ORO	EATON R

AK06:ACTIVITY NAME: SYSTEMS TECHNOLOGY

B&R NO. / CONTRACT NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0600000 ORENG26 OAK RIDGE NATIONAL LAB NOVEL COATINGS	OAKR	TN03	012	150	150	0	0	ORO	EATON R
AK0600000 ORENG26 OAK RIDGE NATIONAL LAB METAL/DIELECTRIC INTERFACES	OAKR	TN03	013	100	100	0	0	ORO	EATON R
AK0600000 RL01830 PACIFIC NORTHWEST LABS TECHNICAL & ECONOMIC ANALYSIS	RICH	WA04	001	146	146	0	0	RLO	LEVINSON T
AK0600000 RL01830 PACIFIC NORTHWEST LABS ELECTRIC POWER RESEARCH	RICH	WA04	002	500	500	0	0	RLO	KLEIN K
AK0600000 ET26950 PUBLIC SV ELEC & GAS CO TECH & ECON ASSESSMENT OF EES	NEWA	NJ12	001	100	100	0	0	CHO	KLEIN K

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AK06:ACTIVITY NAME: SYSTEMS TECHNOLOGY

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0600000 ET29368 NEWA NJ12 PUBLIC SV ELEC & GAS CO BATTERY ENERGY STORAGE TEST FAC	001	600	600	0	0	CHO	KLEIN K
AK0600000 CE76262 GAI MD08 SHAH & ASSOC. ELECTRIC POWER PROGRAMS AT HBCU'S	001	24	24	0	0	WHQ	ROESLER D
AK0600000 CE76252 GAI MD08 SHAH & ASSOCIATES EVALUATION OF ELECTRIC POWER PRGM OPPOR	001	0	0	0	0	WHQ	DUNLOP R
AK0600000 CE76250 READ MA07 TASC, INC. DISTURBANCE RECOGNITION AND SYSTEM IMPA	001	175	175	0	0	WHQ	ROESLER D
AK0600000 CE76257 BERK CA01 UNIV. OF CALIFORNIA/BERKELEY DISTURBANCE RECOGNITION AND SYSTEM IMPA	001	125	125	171	0	WHQ	ROESLER D

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AK06:ACTIVITY NAME: SYSTEMS TECHNOLOGY

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AK0600000 CE76237 ALE VA08 VSE CORPORATION HAWAII DEEP WATER CABLE TECH. & MGMT. P	001	480	480	262	0	WHQ	EATON R
AK06 ACTIVITY TOTAL		15,735	11,175	3,063	2,573		

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AK10:ACTIVITY NAME: SYS ARCHITECTURE AND INTEGRATION

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	CHARD OFFICE	PROJECT MANAGER
AK1005000 ORENG26 OAK RIDGE NATIONAL LAB CASCADE/UNCOSTED OBLIGATIONS	107	0	0	0	0	ORO	ROESLER D
AK1005010 ET29079 UNITED TECH CORP ADVANCED POWER CONVERTERS	010	0	0	0	0	WHQ	ROESLER D
AK1010000 ORENG26 OAK RIDGE NATIONAL LAB ATHENS DISTRIBUTION AUTOMATION PROJECT	005	0	0	0	0	ORO	ROESLER D
AK1015000 ET29101 PURDUE UNIV HYBRID SIMULATOR-NO COST TIME EXT.	001	0	0	0	0	CHO	ROESLER D
AK10 ACTIVITY TOTAL		0	0	0	0		

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AL05:ACTIVITY NAME: BATTERY STORAGE

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AL0501000 CHENG38 ARG IL13 ARGONNE NATIONAL LAB NATIONAL BATTERY TEST LABORATORY	001	805	805	730	0	CHO	RUBY S
AL0501000 CH00016 NO NY01 BROOKHAVEN NATIONAL LAB FUEL CELL CATALYST RESEARCH PROGRAM	001	390	390	230	300	CHO	RUBY S
AL0501000 SF00098 BERK CA01 LAWRENCE BERKELEY LAB APPLIED BATTERY & ELECTROCHEM RES	001	4,487	4,487	3,670	4,550	SFO	RUBY S
AL0501000 SFENG48 LIV CA09 LAWRENCE LIVERMORE LAB ALUMINUM AIR BATTERIES	001	1,050	1,050	445	0	SFO	RUBY S
AL0501000 SFENG48 LAWRENCE LIVERMORE LAB ZINC DIFFUSION	002	65	65	50	0	SFO	RUBY S

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AL05:ACTIVITY NAME: BATTERY STORAGE

B&R NO. / CONTRACT NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AL0501000 ALENG36 LOS ALAMOS SCIENTIFIC LAB FUEL CELLS OF VEHICLES	LOS	NM03 001	001	1,110	1,110	1,125	1,000	ALO	RUBY S
AL0501000 ORENG26 OAK NATIONAL LAB DEV NEW BETA-DBL-PRIME AL ELECT	OAKR	TN03 001	001	150	150	0	0	ORO	RUBY S
AL0502000 CHENG38 ARGONNE NATIONAL LAB, NATIONAL BATTERY TEST LAB & MOLTEN-SALT	ARG	IL13 001	001	1,200	1,200	1,000	300	CHO	RUBY S
AL0502000 CE90038 NAVY DEPT OF NI-ZN BATTERY FOR ELECTRIC VEHICLE APPL	GRA	IN08 001	001	5	5	0	0	WHQ	RUBY S
AL0502000 ORENG26 OAK RIDGE NATIONAL LAB THERMAL ENERGY STORAGE PROGRAM	OAKR	TN03 001	001	60	60	0	0	ORO	SHIVERS R

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AL05:ACTIVITY NAME: BATTERY STORAGE

B&R NO. / CONTRACT NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AL0502000 DP00789 SANDIA NATIONAL LAB EXPLORATORY TECHNOLOGY DEV & TESTING	ALBU	NM02	001	5,616	5,616	1,944	4,450	ALO	LANDGREBE
AL0503000 CE90230 AIR FORCE DEPT OF TECHNOLOGY MGMT AND ASSESSMENT	WAS	DC98	001	0	0	0	0	WHQ	LEVINSON T
AL0503000 CS35217 AIR FORCE DEPT OF TECHNOLOGY MANAGEMENT AND ASSESSMENT FO	WAS	DC98	001	0	0	0	0	WHQ	LEVINSON T
AL0503000 CE90148 DOE ADMINISTRATIVE SERVICES ELECTROCHEMICAL STORAGE & CONVER/BATTER	WAS	DC98	001	2	2	0	0	WHQ	LANDGREBE
AL0503000 RL01830 PACIFIC NORTHWEST LABS TECHNICAL AND ECONOMIC ANALYSIS	RICH	WA04	001	1,010	1,010	340	0	RLO	QUINN J

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AL05:ACTIVITY NAME: BATTERY STORAGE

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AL0503000 RL01830 RICH WA04 PACIFIC NORTHWEST LABS TECHNOLOGY ANALYSIS AND EVALUATION	002	164	164	0	0	RLO	LEVINSON T
AL0505050 CHENG38 ARG IL13 ARGONNE NATIONAL LAB NATIONAL BATTERY TEST LAB & MOLTEN-SALT	005	0	0	0	0	CHO	RUBY S
AL0505100 CHENG38 ARG IL13 ARGONNE NATIONAL LAB NATIONAL BATTERY TEST LABORATORY	003	0	0	0	0	CHO	RUBY S
AL0510050 SFENG48 LIV CA09 LAWRENCE LIVERMORE LAB METAL AIR BATTERY	001	0	0	0	0	SFO	RUBY S
AL0510050 ALENG36 LOS NM03 LOS ALAMOS SCIENTIFIC LAB ELECTROCHEMICAL PHENOMENA	001	0	0	0	0	ALO	RUBY S

AL05:ACTIVITY NAME: BATTERY STORAGE

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY / STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AL0510050 OAK RIDGE NATIONAL LAB DEV NEW BETA-DBL-PRIME AL ELECT	OREN026	OAKR TN03	001	0	0	0	0	ORO	RUBY S
AL0510100 BROOKHAVEN NATIONAL LAB MATERIALS CHEMISTRY OF FUEL CELLS	CH00016	NO NY01	002	0	0	0	0	CHO	RUBY S
AL0510100 LAWRENCE BERKELEY LAB ENERGY PRODUCTIVITY IN END-USE SECTORS	SF00098	BERK CA01	005	0	0	0	0	SFO	LEVINSON T
AL0510100 PACIFIC NORTHWEST LABS TECHNOLOGY ANALYSIS & EVALUATION	RL01830	RICH WA04	001	0	0	0	0	RLO	QUINN J
AL0510100 SANDIA NATIONAL LAB MEMBRANE RESEARCH	DP00789	ALBU NM02	001	0	0	0	0	ALO	LANDGREBE
AL05 ACTIVITY TOTAL				16,114	16,114	9,534	10,600		

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AL10:ACTIVITY NAME: THERMAL AND MECHANICAL STORAGE

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AL1001000 AIR FORCE DEPT OF TECHNOLOGY MGMT AND ASSESSMENT	CE90230	WAS	DC98	001	0	0	0	0	WHQ	LEVINSON T
AL1001000 AIRFORCE DEPT OF TECHNOLOGY MANAGEMENT AND ASSESSMENT	CS35217	WAS	DC98	001	0	0	0	0	WHQ	LEVINSON T
AL1001000 LAWRENCE BERKELEY LAB NOVEL THERMAL STORAGE CONCEPTS	SF00098	BERK	CA01	001	200	200	235	0	SFO	SHIVERS R
AL1001000 OAK RIDGE NATIONAL LAB THERMAL ENERGY STORAGE PROG.	ORENG26	OAKR	TN03	001	830	830	980	0	ORO	SHIVERS R
AL1001000 PACIFIC NORTHWEST LABS UNDERGROUND ENERGY STORAGE PROGRAM	RL01830	RICH	WA04	001	500	500	480	270	RLO	SHIVERS R

AL10:ACTIVITY NAME: THERMAL AND MECHANICAL STORAGE

B&R NO. / CONTRACT NO. / CITY / STATE / CONG. / CONTRACTOR NAME / DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AL1001000 CH10093 GOI C002 SOLAR ENERGY RESEARCH SOLAR ENERGY STORAGE PROGRAM	001	50	50	150	150	CHO	GUREVICH M
AL1001000 ET26106 MIL WI05 WISCONSIN UNIV OF SYNTHESIS OF R&D IN MECHANICAL AND THER	001	135	135	0	0	CHO	SHIVERS R
AL1002000 CH00016 NO NY01 BROOKHAVEN NATIONAL LAB CHEMICAL/HYDROGEN	002	400	400	975	980	CHO	GUREVICH M
AL1002000 CE90147 WAS DC98 DOE PRINTING ANNUAL REPORT-HYDRO ENE COORD COM MTG	001	1	1	0	0	WHQ	GUREVICH M
AL1002000 SF00098 BERK CA01 LAWRENCE BERKELEY LAB NOVEL THERMAL STORAGE CONCEPTS	001	100	100	235	0	SFO	SHIVERS R

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AL10:ACTIVITY NAME: THERMAL AND MECHANICAL STORAGE

B&R NO. / CONTRACT NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AL1003000 ALEN036 LOS ALAMOS SCIENTIFIC LAB SUPERCONDUCTING MAGNETIC ENERGY STORAGE	LOS	NM03	001	275	275	0	0	ALO	SHIVERS R
AL1004000 CH00016 BROOKHAVEN NATIONAL LAB CHEMICAL ENGINEERING PRACTICE	BRO	NY01	001	15	15	0	0	CHO	BROGAN J
AL1004000 RL01830 PACIFIC NORTHWEST LABS TECHNICAL AND ECONOMIC ANALYSIS	RICH	WA04	001	65	65	20	100	RLO	QUINN J
AL1004000 RL01830 PACIFIC NORTHWEST LABS TECHNOLOGY ANALYSIS & EVALUATION	RICH	WA04	002	85	85	0	0	RLO	LEVINSON T
AL1005050 SF00098 LAWRENCE BERKELEY LAB NOVEL THERMAL STORAGE CONCEPTS	BERK	CA01	001	0	0	0	0	SFO	SHIVERS R

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AL10:ACTIVITY NAME: THERMAL AND MECHANICAL STORAGE

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
AL1005050 OAK RIDGE NATIONAL LAB THERMAL ENERGY STORAGE	ORENG26	OAK R	TN03	002	0	0	0	0	ORO	SHIVERS R
AL1005050 SOLAR ENERGY RESEARCH SOLAR ENERGY STORAGE PROGRAM	CH00178	GOL	C002	001	0	0	0	0	CHO	GUREVICH M
AL1005050 SOLAR ENERGY RESEARCH SOLAR ENERGY STORAGE PROGRAM	CH10093	GOL	C002	001	0	0	0	0	CHO	GUREVICH M
AL1005109 BROOKHAVEN NATIONAL LAB CHEMICAL/HYDROGEN ENERGY STORAGE	CH00016	NO	NY01	006	0	0	0	0	CHO	GUREVICH M
AL1005150 BROOKHAVEN NATIONAL LAB CHEMICAL-HYDROGEN ENERGY STORAGE	CH00016	BRO	NY01	001	0	0	0	0	CHO	GUREVICH M

ALIC:ACTIVITY NAME: THERMAL AND MECHANICAL STORAGE

BSR NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
ALI010050 ORENG26 OAKR TN03 OAK RIDGE NATIONAL LAB THERMAL ENERGY STORAGE PROGRAM	002	0	0	0	0	ORO	SHIVERS R
ALI010050 C590103 TRANSPORTATION DEPT OF UMTA - NO COST EXTENSION	001	0	0	0	0	HHQ	RUBY S
ALI010100 RL01830 RICH WA04 PACIFIC NORTHWEST LABS UNDERGROUND ENERGY STORAGE PROGRAM	001	0	0	0	0	RLO	SHIVERS R
ALI010200 ALENG36 LOS NM03 LOS ALAMOS SCIENTIFIC LAB SUPERCONDUCTING MAGNETIC ENERGY STORAGE	001	0	0	0	0	ALO	SHIVERS R
ALIO ACTIVITY TOTAL		2,656	2,656	3,075	1,500		

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35AK:ACTIVITY NAME: ELECTRIC ENERGY SYSTEMS

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
35AK06000 ARGONNE NATIONAL LAB CIRADIAN PHASE SHIFT RESEARCH	CHENG38	ARG	IL13	001	10	10	0	0	CHO	KLEIN K
35AK06000 NATIONAL BUREAU STANDARD SUPPORT OF RESEARCH PROJECTS	CE76201	WAS	DI98	001	90	90	0	0	WHQ	KLEIN K
35AK06000 OAK RIDGE NATIONAL LAB GASEOUS DIELECTRIC RESEARCH	ORENG26	OAKR	TN03	001	130	130	0	0	ORO	KLEIN K
35AK06000 PACIFIC NORTHWEST LABS ELECTRIC POWER RESEARCH	RL01830	RICH	WA04	001	55	55	0	0	RLO	KLEIN K
35AK ACTIVITY TOTAL					285	285	0	0		

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35AL:ACTIVITY NAME: STOR CAPITAL EQUIPMENT

B&R NO. / CONTRACT NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
35AL05000 CHENG38 ARGONNE NATIONAL LAB CAPITAL EQUIPMENT FOR BATTERY TESTING	ARG	IL13	008	160	160	100	0	CHO	RUBY S
35AL05000 CH00016 BROOKHAVEN NATIONAL LAB FUEL CELLS	BRO	NY01	001	35	35	0	0	CHO	RUBY S
35AL05000 SF00098 LAWRENCE BERKELEY LAB CAPITAL EQUIPMENT FOR BATTERY RESEARCH	BERK	CA01	001	150	150	75	0	SFO	RUBY S
35AL05000 ALENG36 LOS ALAMOS NATIONAL LABORATORY FUEL CELLS FOR VEHICLE APPLICATION	LOS	NM03	002	40	40	0	0	ALO	RUBY S
35AL05000 RL01830 PACIFIC NORTHWEST LABS CAPITAL EQUIP. FOR BATTERY RESEARCH	RICH	WA04	001	15	15	0	0	RLO	QUINN J

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35AL ACTIVITY NAME: STOR CAPITAL EQUIPMENT

BAR NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
35AL05000 DP00709 ALBU NMOI SANDIA LIVERMORE LABORATORIES CAPITAL EQUIPMENT FOR BATTERY DEVELOPME	001	100	100	17	0	ALO	LANDGREBE
35AL ACTIVITY TOTAL		900	900	192	0		
DIVISION TOTAL		44,319	39,756	20,091	18,300		

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EB22-ACTIVITY NAME: PHOTOVOLTAIC ENERGY SYSTEMS

BBR NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2201000 TB00000 ALBU NM03 ALBUQUERQUE OPER OFFICE PV RESIDENTIAL STATIONS (TR FROM SANDIA	016	1,112	1,112	0	0	ALO	KRANTZ A
EB2201000 CH00016 VPF NO01 BROOKHAVEN NATIONAL LAB PV ENVIRON HEALTH & SAFETY	034	234	234	270	0	CHO	BULAWKA A
EB2201000 CH00016 VPF NO01 BROOKHAVEN NATIONAL LAB AMORPHOUS MATERIALS	160	285	285	0	0	CHO	HERMIG L
EB2201000 MA32625 HAS DI98 CALCULON DISPLAYWRITER/PC SUPPORT	004	3	3	0	0	WHQ	BACK P
EB2201000 CE00009 HAS DI98 DOE ADMINISTRATIVE SERVICES FY 84 PHOTOVOLTAIC PROGRAM SUMMARY	001	5	5	10	10	WHQ	RICE V

EB22:ACTIVITY NAME: PHOTOVOLTAIC ENERGY SYSTEMS

B&R NO. / CONTRACT NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB22C1000 CE89010 DOE ADMINISTRATIVE SERVICES 1984 ANN PROGRESS REPORT-PHOTO.			001	3	3	0	0	WHQ	RICE V
EB2201000 CE30784 MERIDIAN CORP RE SUPPORT SERVICE (PHOTOV)	ZZOTH	VG10	004	921	586	718	200	WHQ	LOOSE R
EB2201000 ET20279 MIT-LINCOLN LAB SUPPLEMENTAL FUNDING	CAM	MA08	001	350	350	0	0	CHO	KRANTZ A
EB2201000 ET20356 NASA PV MATERIALS & SUPPORT RES	WAS	DI98	106	12,724	12,724	6,100	0	WHQ	PRINCE M
EB2201000 RL01830 PACIFIC NORTHWEST LAB PV TECH ASSESSMENT	RICH	WA04	151	50	50	95	0	RLO	RICE V

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EB22:ACTIVITY NAME: PHOTOVOLTAIC ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2201000 DP00789 ALBU NM03 SANDIA LAB REALLOCATION TO ALO FOR PV RESID. STATI	112	1,112CR	1,112CR	0	0	ALO	KRANTZ A
EB2201000 DP00789 ALBU NM03 SANDIA LAB PV SUPPORT RESEARCH	151	20,911	10,619	11,393	3,000	ALO	RICE V
EB2201000 OR20837 WAS DI98 SCIENCE APPLICATIONS OSET R&D STRATEGY DEV.	001	24	24	0	0	ORO	MOORE G
EB2201000 CH00178 GOL CO05 SOLAR ENERGY RESEARCH DEOBLIGATION/REDIRECT TO BNL	150	285CR	285CR	0	0	CHO	HERWIG L
EB2201000 CH10093 GOL CO05 SOLAR ENERGY RESEARCH HYDROGEN RESEARCH	004	40	40	0	0	CHO	KLUNDER K

EB22:ACTIVITY NAME: PHOTOVOLTAIC ENERGY SYSTEMS

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2201000 SOLAR ENERGY RESEARCH MATERIALS & RES (GRH REDUCTION)	CH10093	GOL	CO05	150	21,576	21,576	23,765	16,250	CHO	HERWIG L
EB22 ACTIVITY TOTAL					56,841	46,214	42,351	19,460		

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35EB:ACTIVITY NAME: SOLAR ENERGY

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
35EB22000 TBD0000 PNL WA05 INTERNATIONAL BUS MACH RE PERSONAL COMPUTERS	007	43	43	0	0	WHQ	FLORANCE J
35EB22000 DP00789 ALBU NM03 SANDIA LIVERMORE LAB PHOTOVOLTAIC SUPPORTING CAP EQ	105	107	107	255	0	ALO	RICE V
35EB22000 CH10093 GOL C005 SOLAR ENERGY RESEARCH MATL-ADV CONCEPT SUPPORT	121	230	230	0	0	CHO	HERWIG L
35EB ACTIVITY TOTAL		380	380	255	0		

39EB:ACTIVITY NAME: SOLAR ENERGY

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
39EB22010 CE30701 SAC CA04 SACRAMENTO MUNICIPAL UTIL DIST 100 MWE PV EXPERIMENT	001	9,100	9,100	0	0	SFO	PULSCAK M
39EB ACTIVITY TOTAL		9,100	9,100	0	0		
DIVISION TOTAL		66,321	55,694	42,606	19,460		

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CE10:ACTIVITY NAME: SMALL SCALE HYDRO DEV

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
CE1002000 ID01570 IDAHO NTL ENGNG LAB SMALL HYDRO DEVELOPMENT	062	381	381	453	500	IDO	FLYNN J
CE10 ACTIVITY TOTAL		381	381	453	500		

EB27:ACTIVITY NAME: INTERNATIONAL SOLAR ENERGY PROGRAM

B&R NO. / CONTRACT NO. / CITY / STATE / CONTRACTOR NAME / CONG. / DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2700000 TBD0000 CHICA IL04 CHICAGO OPERATIONS OFF SOLERAS UNIV PRGM-FY 84 C/O	001	570	570	0	0	CHO	MOORE K
EB2700000 CE30783 WAS DI98 COMMERCE DEPT OF ITA-INTERNATIONAL TRADE DEV	014	301	301	250	250	WHQ	LOOSE R
EB2700000 DP00789 SANDI NM01 SANDIA LIVERMORE LABORAT RENEWABLE ENERGY COMMERCE & TRADE CMTE	001	200	200	712	250	ALO	ANNAN R
EB27 ACTIVITY TOTAL		1,071	1,071	962	500		

EB28:ACTIVITY NAME: SOLAR TECHNOLOGY TRANSFER

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2800000 ADVANCED SCIENCES INC CONS & RENEW ENERGY INFOR & REFERRAL SV	CE30780	WAS	DI98	001	1,675	1,675	600	450	WHQ	MOORE G
EB2800000 CHICAGO OPERATION OFF RETSIE SUPPORT	TBD0000	CHICA	IL04	200	55	55	0	0	CHO	MOORE K
EB2800000 DOE ADMINISTRATIVE SERVICES PRINT 8TH REPORT TO CONGRESS	CE30847	WAS	DI98	847	1	1	0	0	WHQ	HOLMES J
EB2800000 DOE ADMINISTRATIVE SERVICES RENEWABLE ENERGY OUTLOOK	CE30857	WAS	DI98	001	2	4	0	0	WHQ	MOORE K
EB2800000 ETEC SOLAR TECHNOLOGY TRANSFER ASSESSMENT	SF30700	CANO	CA26	028	38	38	0	0	SFO	HOLMES J

EB28:ACTIVITY NAME: SOLAR TECHNOLOGY TRANSFER

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2800000 CE30784 ZZOTH VG10 MERIDIAN CORP RE SUPPORT SERVICE (DAS-RTI)	010	130	130	0	0	WHQ	LOOSE R
EB2800000 TBD0000 OAKRI TN03 OAK RIDGE OPER OFFICE FUND "ENERGY USA" EXHIBIT	001	4	4	0	0	ORO	DEVINE K
EB2800000 TBD0000 WAS DI98 OFFICE OF COMPUTER SERVICES ELECTRONIC MAIL UNOBLIGATED BAL	005	4	4	0	0	WHQ	HOLMES J
EB2800000 OR20837 OAKRI TN05 SCIENCE APPLICATIONS SAI RE ASSESS	001	100	100	0	0	ORO	MOORE K
EB2800000 CH10093 GOL C005 SOLAR ENERGY RESEARCH SOLAR INFO PRGM ACTIVITIES	427	3,307	3,307	2,300	1,400	CHO	MOORE G

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EB28:ACTIVITY NAME: SOLAR TECHNOLOGY TRANSFER

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2800000 CH10093 GOL C005 SOLAR ENERGY RESEARCH UTILITY & FINANCE RE INVESTMENT INFO RE	627	108	108	0	0	CHO	HOLMES J
EB2800000 CE30380 WAS DI98 TECH INFO CENTRE SOLAR PROGRAM PRINTING	002	50	50	0	0	WHQ	HOLMES J
EB28 ACTIVITY TOTAL		5,474	5,476	2,900	1,850		

EB29:ACTIVITY NAME: SOLAR PROGRAM SUPPORT

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2900000 CE30784 ZZOTH VG10 MERIDIAN CORP RE SUPPORT SERVICE (DAS/RTI)	001	210	710	0	0	WHQ	LOOSE R
EB2900000 CS35156 WAS DI98 PUBLIC TECHNOLOGY INC DISPUTED CONTRACT COST	001	7	7	0	0	WHQ	BUDZICH R
EB2900000 OR20837 ZZOTH VG10 SCIENCE APPLICATIONS RENEWABLE ENERGY TECH DEV ASSMT	011	126	126	0	0	ORO	MOORE G
EB2900000 CE30848 ZZOTH VG10 SOCIO ECONOMIC SYSTEM ASSESSMENT OF OPERATIONS	001	75	75	0	0	WHQ	MOORE G
EB2900000 CH10179 GOL C005 SYSTEMATIC MANAGEMENT SERI SITE OFFICE SUPPORT SVC	001	85	85	0	0	CHO	COSTELLO R

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EB29:ACTIVITY NAME: SOLAR PROGRAM SUPPORT

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2900000 CE30844 UNIDENTIFIED RENEWABLE ENERGY SUPPORT SVC-RFP (-49	0 001	0	0	353	297	MHQ	LOOSE R
EB29 ACTIVITY TOTAL		503	1,003	353	297		
DIVISION TOTAL		7,429	7,931	4,668	5,147		

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CASH-ACTIVITY NAME: FEDERAL BUILDINGS

NAME OF ORG. CONTRACTOR NAME DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE	CONG.	NAME CLASS CODE	ESTIMATED FY-83 $/S	AUTHORIZED FY-83 $/S	PLANNED FY-84 $/S	PLANNED FY-85 $/S	ENERGY OFFICE	PROJECT MANAGER
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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EA09 ACTIVITY NAME: MARKET ANALYSIS

BAR NO. CONTRACT NO. CITY STATE CONTRACTOR NAME COND. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EA0500000 CE30784 ZZOTH 9010 MERIDIAN CORP RE SUPPORT SERVICE (ACTIVE BLDGS)	001	1	1	0	0	HQ	LOOSE R
EA05 ACTIVITY TOTAL		1	1	0	0		

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EB21:ACTIVITY NAME: SOLAR BUILDINGS ENERGY SYSTEMS

BAR NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2100000 CE30852 DOE ADMINISTRATIVE SERVICES PRINT COSTS - CONF. PROCEED	001	3	3	3	0	WHQ	TAYLOR L
EB2110000 TBD0000 ZZOTH CA11 ACUREX CORP THIN FILM COLLECTOR PRDA	002	125	125	0	0	SFO	GOLDSMITH
EB2110000 CHEN038 ARG IL13 ARGONNE NATIONAL LAB PROGRAM CLOSEOUT	028	175	175	75	0	CHO	PELLISH D
EB2110000 CHEN038 ARG IL13 ARGONNE NATIONAL LAB MULTI-LOAD COLLECTOR-STORAGE DIST	040	110	42	0	0	CHO	PELLISH D
EB2110000 CHEN038 ARG IL13 ARGONNE NATIONAL LAB DESICCANT MATERIALS RESEARCH	048	225	225	0	0	CHO	PELLISH D

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EB21:ACTIVITY NAME: SOLAR BUILDINGS ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2110000 TBD0000 TEMPE AN01 ARIZONA STATE UNIV OPEN CYCLE ABSORPTION	007	100	100	0	0	SFO	SCHULER J
EB2110000 CH00016 VPF NO01 BROOKHAVEN NATIONAL LAB IEA SUPPORT-IMPL AGREE	016	6	6	0	0	CHO	PELLISH D
EB2110000 CH00016 VPF NO01 BROOKHAVEN NATIONAL LAB POLYMER/FOIL RESEARCH	046	320	320	75	0	CHO	PELLISH D
EB2110000 MA32625 WAS DI98 CALCULON DISPLAYWRITER/PC SUPPORT	002	1	1	0	0	WHQ	BACK P
EB2110000 TBD0000 CH IL03 CHICAGO UNIV OF INTEGRATED CPC COLLECTORS	001	50	10	0	0	SFO	GOLDSMITH

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E021:ACTIVITY NAME: SOLAR BUILDINGS ENERGY SYSTEMS

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2110000 COLORADO STATE UNIV TEST PROGRAM	TBD0000	ZZOTH	CO04	013	415	415	600	0	SFO	HASSETT R
EB2110000 DREXEL UNIVERSITY CONTROL MODELING	TBD0000	PHI	PA01	001	65	65	0	0	SFO	GOLDSMITH
EB2110000 ETEC CORP PROGRAM DOCUMENTATION	SF00700	CANO	CA26	020	117	102	0	0	SFO	SCHULER J
EB2110000 INTERNATIONAL BUSINS SVC COST OVERRUN	CS30607	WAS	DI98	004	2	2	0	0	WHQ	GOLDSMITH
EB2110000 LAWRENCE BERKELEY LAB ACTIVE SUPPORT	SF00098	BERK	CA01	009	400	355	270	0	SFO	PELLISH D

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EB21:ACTIVITY NAME: SOLAR BUILDINGS ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2110000 SF00098 BERK CA01 LAWRENCE BERKELEY LAB SYSTEM ANALYSIS	100	140	140	0	0	SFO	HASSETT R
EB2110000 ALENG36 LOS NM03 LOS ALAMOS NATIONAL LAB SYSTEM EFFECTIVENESS	084	70	70	0	0	ALO	HASSETT R
EB2110000 CE30784 ZZOTH VA10 MERIDIAN CORP RE SUPPORT SERVICE (ACTIVE SOLAR)	002	233	182	177	0	WHQ	LOOSE R
EB2110000 CS36010 WAS DI98 NATIONAL BUREAU OF STDS CONTROL STRATEGIES	006	125	125	0	125	WHQ	HASSETT R
EB2110000 CS36010 WAS DI98 NATIONAL BUREAU OF STDS TEST METHODS OF COLLECTORS	023	65	65	0	0	WHQ	HASSETT R

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EB21:ACTIVITY NAME: SOLAR BUILDINGS ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONG. / CONTRACTOR NAME / DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2110000 CS36010 WAS DI98 NATIONAL BUREAU OF STDS SYSTEM ANALYSIS	041	300	300	125	150	WHQ	HASSETT R
EB2110000 CS36010 WAS DI98 NATIONAL BUREAU OF STDS IEA TASK III	047	20	20	0	0	WHQ	SCHWEITZER
EB2110000 CS36010 WAS DI98 NATIONAL BUREAU OF STDS RATING PROCEDURE FOR INTEG COLLECT STOR	048	80	80	0	0	WHQ	SKALKA M
EB2110000 TBD0000 WAS DI98 OFFICE OF COMPUTER SERVICES ELECTRONIC MAIL UNOBLIGATED BAL	001	4	4	0	0	WHQ	HOLMES J
EB2110000 SF11922 RICH VG03 REYNOLDS METALS CO COLLECT MATERIALS & COMPOENETS	001	0	0	0	0	WHQ	SCHULER J

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EB21:ACTIVITY NAME: SOLAR BUILDINGS ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2110000 TBD0000 SANFA CA08 SAN FRANCISCO OPS THIN FILM COLLECTOR DEV	074	50	50	0	0	SFO	SCHULER J
EB2110000 TBD0000 SANFA CA08 SAN FRANCISCO OPS LARGE SCALE SYSTEM EVALUATION	075	83	83	0	0	SFO	SCHULER J
EB2110000 TBD0000 SANFA CA08 SAN FRANCISCO OPS ACTIVE SOLAR DESIGN WORKSHOP	120	30	30	0	0	SFO	SCHULER J
EB2110000 TBD0000 SANFA CA08 SAN FRANCISCO OPS THIN FILM COLLECTOR & MTL WORKSHOP	121	25	25	0	0	SFO	SCHULER J
EB2110000 TBD0000 SANFA CA08 SAN FRANCISCO OPS US - ISRAEL AGREEMENT	122	75	75	0	0	SFO	SCHULER J

EB21:ACTIVITY NAME: SOLAR BUILDINGS ENERGY SYSTEMS

B&R NO. / CONTRACT NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CITY / STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2110000 TBD0000 SAN FRANCISCO OPS MATERIALS PROG. REVIEW	SANFA CA08	123	10	10	0	0	SFO	SCHULER J
EB2110000 TBD0000 SAN FRANCISCO OPS IEA & BILATERAL SUPPORT RFP	SANFA CA08	124	25	25	0	0	SFO	SKALKA M
EB2110000 TBD0000 SAN FRANCISCO OPS SOLAR BLDGS CONF	SANFA CA08	125	30	30	0	0	SFO	SKALKA M
EB2110000 CH10093 SERI SYSTEMS INTEGRATION TASKS 8,10,11,12,15	GOL C005	101	55	55	655	500	CHO	HASSETT R
EB2110000 CH10093 SERI SVS EFFECTIVENESS RES-EXPMTS	GOL C005	103	250	250	250	0	CHO	HASSETT R

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B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2110000 SERI RESEARCH QUALITY ENHANCEMENT	CH10093	GOL	CO05	375	7	7	155	0	CHO	HASSETT R
EB2110000 SERI SYS ANAL-HVRRID HEAT & COOL	CH10093	GOL	CO05	429	210	210	300	450	CHO	HASSETT R
EB2110000 SERI IEA TASK X-MATERIALS	CH10093	GOL	CO05	616	10	10	10	450	CHO	GOLDSMITH
EB2110000 SERI DESICCANT COOLING RESEARCH	CH10093	GOL	CO05	624	713	713	570	500	CHO	GOLDSMITH
EB2110000 SERI IEA TASK	CH10093	GOL	CO05	625	15	15	20	0	CHO	TAYLOR L

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B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE	CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2110000 SHELADIA SFO-ACTIVE SOLAR BLDG. SUPPORT	TBD0000	WAS	DI98		001	50	50	0	0	SFO	SCHULER J
EB2110000 TPI IEA SUPPORT	SF11918	ZZOTH	ZZ01		002	35	35	0	0	SFO	SCHWEITZER
EB2110000 WISCONSIN UNIV OF SYSTEM MODEL STUDIES	TBD0000	GRB	WI08		004	100	100	0	0	CHO	SCHWEITZER
EB2120000 AMERICAN INST OF ARCHITECT FOUND INDUSTRY SOLAR BLDGS R& D ASSMT	CE30828	WAS	DI98		001	0	0	0	0	WHQ	TAYLOR L
EB2120000 CALCULON DISPLAYWRITER/PC SUPPORT	HA32625	WAS	DI98		003	1	1	0	0	WHQ	BACK P

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B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2120000 TBD0000 CHICA IL04 CHICAGO OPERATIONS OFF SYS STIM & ANL	099	75	75	0	0	CHO	HOLLIDAY R
EB2120000 TBD0000 CHICA IL04 CHICAGO OPERATIONS OFF IEA TASK VIII	100	202	202	0	0	CHO	JENIOR M
EB2120000 TBD0000 CHICA IL04 CHICAGO OPERATIONS OFF EXPERIMENTAL SYSTEMS RSH	105	60	60	0	0	CHO	HOLLIDAY R
EB2120000 TBD0000 CHICA IL04 CHICAGO OPERATIONS OFF ATRIUM PERFORMANCE	107	100	100	0	0	CHO	PELLISH D
EB2120000 TBD0000 CHICA IL04 CHICAGO OPERATIONS OFF EXPERIMENTAL NON-RESIDENTIAL BLDGS	108	29	29	0	0	CHO	PELLISH D

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B&R NO. / CONTRACT NO. / CITY / STATE / CONTRACTOR NAME / CONG. / DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2120000 TBD0000 CHICA IL04 CHICAGO OPERATIONS OFF SOLAR BLDGS CONSTRUCTION	109	41	41	0	0	CHO	PELLISH D
EB2120000 CE30735 DAY OH06 DAYTON UNIVERSITY OF PHASE CHARGE MATERIALS	001	90	90	0	0	SFO	PELLISH D
EB2120000 CE30836 WAS DI98 DOE ADMINISTRATIVE SERVICES PASSIVE SOLAR UPDATE PRINTING	001	5	2	0	0	WHQ	PELLISH D
EB2120000 CE30840 WAS DI98 DOE ADMINISTRATIVE SERVICES PRINTING OF UPDATE CONF. PROCEEDINGS	001	4	4	0	0	WHQ	DYER R
EB2120000 CE30746 ZZOTH WA09 EIC INC VAR TRANSM ELECTROCHROMIC WINDOW	004	90	90	0	0	SFO	PELLISH D

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EB2120000 SF00098 BERK CA08 LAWRENCE BERKELEY LAB SYS SIM ANAL/PERFORMANCES	087	315	315	460	250	SFO	HOLLIDAY R
EB2120000 SF00098 BERK CA08 LAWRENCE BERKELEY LAB DAYLIGHTING & RESOURCE CHARACT	089	285	285	0	0	SFO	TAYLOR L
EB2120000 SF00098 BERK CA08 LAWRENCE BERKELEY LAB PASSIVE SUPPORT	090	475	475	305	230	SFO	PELLISH D
EB2120000 SF00098 BERK CA08 LAWRENCE BERKELEY LAB HEAT TRANSFER/NATURAL CONV.	091	90	90	90	0	SFO	PELLISH D
EB2120000 SF00098 BERK CA08 LAWRENCE BERKELEY LAB PASSIVE COOLING	093	190	190	270	200	SFO	HOLLIDAY R

[illegible]

[illegible]

[illegible]

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DEPUTY ASSISTANT SECRETARY FOR RENEWABLE ENERGY
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PROJ: ACTIVITY NAME: SOLAR BUILDINGS ENERGY SYSTEMS

SUB NO. CONTRACT NO. CITY STATE CONTRACTOR NAME (CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-83 $/K	AUTHORIZED FY-83 $/K	PLANNED FY-84 $/K	PLANNED FY-87 $/K	OWNER OFFICE	PROJECT MANAGER
EB1120000 ILLINOIS LEI 0003 LEI ILLINOIS NATIONAL LAB THERMAL TRANS/SUB SYS	008	100	100	0	0	ALO	PELLISH D
EB1120000 ILLINOIS LEI 0003 LEI ILLINOIS NATIONAL LAB PASSIVE SOLAR RES	001	3	3	0	0	ALO	JONES D
EB1120000 ILLINOIS LEI ILLINOIS NATIONAL LAB VAPOR TRANSPORT RES	002	93	93	0	0	ALO	REDISE F
EB1120000 T000000 CER 0000 MASSACHUSETTS INST TECH THERMAL TRANSPORT	009	170	170	0	0	SFO	PELLISH D
EB1120000 CE38704 ZZOTH 0014 MERIDIAN CORP RE SUPPORT SERVICE (PASS-BLDG)	003	403	403	203	0	MMO	LOOSE R

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EB21*ACTIVITY NAME: SOLAR BUILDINGS ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2120000 CS30300 WAS DI98 NAHB RESH FOUNDATION PERFORMANCE MONITOR AND EVAL	001	0	0	0	0	CHO	JENIOR M
EB2120000 CS36010 WAS DI98 NATIONAL BUREAU OF STDS EXPERIMENTAL SYSTEMS	033	200	200	0	0	WHQ	JENIOR M
EB2120000 CS36010 WAS DI98 NATIONAL BUREAU OF STDS THERMAL STORAGE MATEIALS	034	80	50	0	0	WHQ	TAYLOR L
EB2120000 CS36010 WAS DI98 NATIONAL BUREAU OF STDS APERTURE MATERIALS	048	60	50	150	0	WHQ	PELLISH D
EB2120000 Y000000 WAS DI98 OFFICE OF COMPUTER SERVICES ELECTRONIC MAIL UNOBLIGATED BAL	003	4	4	0	0	WHQ	HOLMES J

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EB21:ACTIVITY NAME: SOLAR BUILDINGS ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2120000 TBD0000 SANFA CA08 SAN FRANCISCO OPS RES MATERIALS-PASSIVE SOLAR	059	6CR	6CR	0	0	SFO	TAYLOR L
EB2120000 YBD0000 SANFA CA08 SAN FRANCISCO OPS TECHNOLOGY TRANSFER	107	25	25	0	0	SFO	TAYLOR L
EB2120000 TBD0000 SANFA CA08 SAN FRANCISCO OPS APERTURE MTLE COMP	109	150	150	0	0	SFO	PELLISH D
EB2120000 TBD0000 SANFA CA08 SAN FRANCISCO OPS THERMAL STORAGE MATERIALS	110	210	210	0	0	SFO	PELLISH D
EB2120000 CH10093 GOL CO05 SERI IEA TASK	372	35	35	0	0	CHO	TAYLOR L

EB21:ACTIVITY NAME: SOLAR BUILDINGS ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME DESCRIPTION OF WORK	CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2120000 CH10093 GOL C005 SERI TECHNICAL PROG INTEGRATION		376	7	7	185	0	CHO	PELLISH D
EB2120000 CH10093 GOL C005 SERI SYS INTEGRATION		419	293	293	186	0	CHO	JENIOR M
EB2120000 CH10093 GOL C005 SERI DAYLIGHTING & RESOURCE CHARACT		421	150	150	125	0	CHO	JENIOR M
EB2120000 CH10093 GOL C005 SERI APERTURE MATL/LOAD CNTL		422	100	100	485	500	CHO	PELLISH D
EB2120000 CH10093 GOL C005 SERI RENOWNED RESEARCHER		423	150	150	114	0	CHO	MORSE F

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EB21:ACTIVITY NAME: SOLAR BUILDINGS ENERGY SYSTEMS

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2120000 SERI THERMAL STORAGE MATERIAL	CH10093	GOL	CO05	424	100	100	190	0	CHO	PELLISH D
EB2120000 SERI TECHNOLOGY TRANSFER	CH10093	GOL	CO05	426	190	190	0	0	CHO	JENIOR M
EB2120000 TPI IEA SUPPORT	SF11918	ZZOTH	ZZ01	001	55	55	0	0	SFO	TAYLOR L
EB2120000 TUFTS UNIVERSITY OPTICS AND MATERIAL RESEARCH	CE30753	ZZOTH	MA07	001	100	100	0	0	SFO	PELLISH D
EB21 ACTIVITY TOTAL					10,215	9,953	6,538	3,575		

35EB:ACTIVITY NAME: SOLAR ENERGY

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
35EB21100 TBD0000 PNL WA05 INTERNATIONAL BUS MACH MICROCOMPUTER EQ	004	15	15	180	0	HHQ	SCHULER J
35EB21100 SF00098 BERK CA08 LAWRENCE BERKELEY LAB ACTIVE SOLAR CAPITAL EQUIPMENT	103	45	45	0	0	SFO	SCHULER J
35EB21100 CH10093 GOL C005 SOLAR ENERGY RESEARCH ACTIVE SOLAR CAPITAL EQUIPMENT	003	40	40	200	0	CHO	HASSETT R
35EB21200 CH10093 GOL C005 SERI PASSIVE SOLAR CAPITAL EQUIPMENT	182	100	100	300	0	CHO	TAYLOR L
35EB ACTIVITY TOTAL		200	200	680	0		
DIVISION TOTAL		13,630	13,368	7,218	3,575		

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EB23:ACTIVITY NAME: SOLAR THERMAL ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2300000 CS30130 HAS DI98 AGRICULTURE DEPT OF NO COST EXT-SOLAR ENERGY AGRIC. APPL.	001	0	0	0	0	HHQ	GREYERBIEH
EB2300000 TBD0000 ALBUQUERQUE OPER OFC INNOVATIVE CONCENTRATOR PROGRAM	001	200	200	0	0	ALO	MORSE F
EB2300000 TBD0000 ALBU NM03 ALBUQUERQUE OPER OFC DISH ADVANCED CONCENTRATOR	010	2,000	2,000	865	450	ALO	SCHEVE M
EB2300000 TBD0000 ALBU NM03 ALBUQUERQUE OPER OFC MOLOKAI SMALL COM-SITE DEV	011	200	200	0	0	ALO	SCHEVE M
EB2300000 TBD0000 ALBU NM03 ALBUQUERQUE OPER OFC SEC SMALL COM EXPT/PT FOCUS CONC(FRM SA	017	8,888	8,888	0	0	ALO	SCHEVE M

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EB23:ACTIVITY NAME: SOLAR THERMAL ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONG. CONTRACTOR NAME DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2300000 MA32625 WAS DI98 CALCULON DISPLAYWRITER/PC SUPPORT	005	5	4	5	0	WHQ	BACK P
EB2300000 TBD0000 OH06 DAY DAYTON UNIVERSITY OF UNIVERSITY SOLAR THERMAL RESEARCH	002	13	13	0	0	WHQ	CARWILE C
EB2300000 ET20609 ZZOTH ZZ01 INTERNATIONAL ENERGY AGENCY IEA/SOLAR SMALL PWR SYS(DFV)	001	150	150	0	150	WHQ	CARWILE C
EB2300000 ET20609 INTERNATIONAL ENERGY AGENCY TASK II,SUBTASK 2, ASR HIGH FLUX EXP	002	110	110	0	0	WHQ	CARWILE C
EB2300000 CE30784 ZZOTH VG10 MERIDIAN CORP RE SUPPORT SERVICE (THERM)	001	303	303	0	250	WHQ	LOOSE R

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EB23:ACTIVITY NAME: SOLAR THERMAL ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2300000 TBD0000 WAS DI98 OFFICE OF COMPUTER SERVICES ELECTRONIC MAIL UNOBLIGATED BAL	004	4	4	0	0	WHQ	HOLMES J
EB2300000 TBD0000 SANFA CA08 SAN FRANCISCO OPER OFC CENTRAL RECEIVER R&D	005	288	308	0	0	SFO	MANGOLD C
EB2300000 TBD0000 SANFA CA08 SAN FRANCISCO OPER OFC GA TECHS & GARRETT CORP SULT ACID	006	308	308	0	0	SFO	GRONICH S
EB2300000 TBD0000 SAN FRANCISCO OPER OFC IEA/DOC PROJ/CSU PROJ	007	95	95	0	0	SFO	PELLISH D
EB2300000 DP00789 ALBU NM01 SANDIA LABS (SNLL) CENT REC TRANSP/STORAGE	013	700	700	0	0	ALO	MANGOLD C

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EB23:ACTIVITY NAME: SOLAR THERMAL ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2300000 DP00789 ALBU NM01 SANDIA LABS CENTRAL RECEIVER R&D	065	2,060	1,918	2,000	1,650	ALO	GRONICH S
EB2300000 DP00789 ALBU NM01 SANDIA LABS CENT REC TEST FAC O&M	068	1,300	1,300	1,500	1,000	ALO	GRONICH S
EB2300000 DP00789 ALBU NM01 SANDIA LABS (SNLL) CENT REC CONTROLS R&D	069	1,400	1,400	600	1,000	ALO	GRONICH S
EB2300000 DP00789 ALBU NM01 SANDIA LABS (SNLA) MOLTEN SALT ELECT EXPMT	078	300	300	0	0	ALO	GRONICH S
EB2300000 DP00789 ALBU NM01 SANDIA LABS (SNLL) CENT REC SYSTEM R&D	080	2,640	2,640	1,930	550	ALO	GRONICH S

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EB23:ACTIVITY NAME: SOLAR THERMAL ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONG. / CONTRACTOR NAME / DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2300000 DP00789 ALBU NM01 SANDIA LABS (SNLA) DISTRIB REC SYS EXMPTS	090	1,050	1,050	250	0	ALO	SCHEVE M
EB2300000 DP00789 ALBU NM01 SANDIA LABS (SNLA) DISTRIB REC/ENGINE R&D (-608 ORH	091	2,475	2,475	1,867	1,500	ALO	MANGOLD C
EB2300000 DP00789 ALBU NM01 SANDIA LABS (SNLA) DISTRIB REC RECEIVER R&D	092	380	380	921	850	ALO	MANGOLD C
EB2300000 DP00789 ALBU NM01 SANDIA LABS (SNLA) DISTRIB REC TEST FAC O&M	093	510	510	500	300	ALO	MANGOLD C
EB2300000 DP00789 ALBU NM01 SANDIA LABS CENT REC ADV CONCENTRATORS	094	1,300	1,300	1,250	500	ALO	SCHEVE M

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EB23:ACTIVITY NAME: SOLAR THERMAL ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2300000 DP00789 ALBU NM01 SANDIA LABS (SMLA) DISTRIB REC TRANSP/STOR R&D	097	600	600	1,220	600	ALO	SCHEVE M
EB2300000 DP00789 ALBU NM01 SANDIA LABS DISTRIB RECEIVER CONC R&D	100	1,810	1,810	1,100	950	ALO	SCHEVE M
EB2300000 DP00789 ALBU NM01 SANDIA LABS (SMLA) SOLAR THERMAL DM CONTROLS	103	140	140	42	0	ALO	SCHEVE M
EB2300000 DP00789 ALBU NM01 SANDIA LABS (SMLA) DISTRIB REC SYS R&D	107	745	745	789	600	ALO	SCHEVE M
EB2300000 DP00789 ALBU NM01 SANDIA LABS REALLOC. TO ALO FOR SEC SMALL COM/CONC	113	0.000CR	0.000CR	0	0	ALO	CARMILE C

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U. S. DEPARTMENT OF ENERGY
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EB03-01710177 GAGE: SOLAR THERMAL ENERGY SYSTEMS

DAN NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK CLSD CODE	ESTIMATED FY-83 $/K	AUTHORIZED FY-83 $/K	PLANNED FY-84 $/K	PLANNED FY-87 $/K	AWARD OFFICE	PROJECT MANAGER
EB1300000 SF03709 ALBU NMEX SANDIA LABS CHALK SODIUM HEAT ENGINE	110	550	550	0	0	ALB	SCHEVE R
EB1100000 S10503 ALBU NMEX SANDIA LABORATORIES LABORAT CR RAE SPC R MAINT	814	1,400	1,400	700	0	ALB	GRUNDIA S
EB1100000 S10503 ALBU NMEX SANDIA LABORATORIES LABORAT TOLH PROGRAM INFORMATION	870	3,000	3,000	0	0	ALB	GARNICE C
EB1100000 S01000 SOL CORP SOLAR ENERGY RESEARCH ADVANCED RECEIVER REC 1-870 DEMO	003	1,000	1,000	921	930	CHO	WOLFERD P
EB1100000 S01000 SOL CORP SOLAR ENERGY RESEARCH TOLH PROG INFORMATION	005	150	150	840	0	CHO	EDLEMAN M

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U. S. DEPARTMENT OF ENERGY
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EXCO ACTIVITY NAME: SOLAR THERMAL ENERGY SYSTEMS

BAR NO. / CONTRACT NO. / CITY / STATE CONTRACTOR NAME DESCRIPTION OF WORK	WORK CLSN CODE	ESTIMATED FY-93 $-K	AUTHORIZED FY-93 $-K	PLANNED FY-94 $-K	PLANNED FY-95 $-K	AWARD OFFICE	PROJECT MANAGER
CALIFORNIA, STATE OF, SOL, CSES SOLAR ENERGY RESEARCH HEAT SOL RES	044	300	300	400	0	CHO	WILKINS F
PETROLEUM, SPIRIT CHEVRON USA CO LOOSE CHPT DPS & RACINT	044	3,000	3,000	2,304	1,900	SPO	GORDON S
EXCO ACTIVITY TOTAL		24,819	24,346	24,883	14,950		

U. S. DEPARTMENT OF ENERGY
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DIVISION OF SOLAR THERMAL TECHNOLOGY

FY 85 PROCUREMENT EXECUTION REPORT
AS OF : 03/13/86

SSEB-ACTIVITY NAME: SOLAR ENERGY

R&D NO. CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO. COND.	CITY	STATE	WORK BLCH CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
31EB23000 TB00000 HRS 3190 INTERNATIONAL BUS MACH RE PERSONAL COMPUTERS				000	10	10	0	0	NMO	FLORANCE J
31EB23000 SP00789 ALBU NMEX SANDIA LABS SOALR THERMAL CAPITAL EQUIPMENT (-11 GR				104	130	130	89	0	ALO	MANOOLD C
31EB23000 CS00011 ALBU NMEX SANDIA LIVERMORE LABORAT SOLAR THERMAL CAPITAL EQUIPMENT				096	140	140	100	0	ALO	MANOOLD C
31EB23000 CM10093 OBL COES SOLAR ENERGY RESEARCH SOLAR THERMAL CAPITAL EQ				096	200	200	100	0	CHO	HILKINS P
SSEB ACTIVITY TOTAL					300	300	289	0		
DIVISION TOTAL					35,319	35,046	25,172	14,950		

EB25:ACTIVITY NAME: WIND ENERGY SYSTEMS

BBR NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2501000 ET20320 WAS DI98 NASA MOD5B LARGE SCALE TURBINE	004	15,500	15,000	11,347	0	WHQ	ANCONA D
EB2502000 CE89207 ALBUQ NM03 ALBUQUERQUE OPER OFC STATE OF THE ART FIELD TEST PROJ	207	274	109	100	0	ALO	ANCONA D
EB2502000 CE89208 ALBUQUERQUE OPER OFC TECH MANAGEMENT SUPPORT	001	165	165	0	0	ALO	DYES D
EB2502000 WA32625 WAS DI98 CALCULON DISPLAYWRITER/PC SUPPORT	008	2	2	15	0	WHQ	BACK P
EB2502000 CE30784 ZZ01H V018 MERIDIAN CORP RE SUPPORT SERVICE (WIND)	006	296	296	745	250	WHQ	LOOSE R

EB29:ACTIVITY NAME: WIND ENERGY SYSTEMS

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2502000 NASA SUPPORT RESEARCH & TECH DEV	ET20320	WAS	DI98	059	3,000	3,000	0	170	WHQ	ANCONA D
EB2502000 SCIENCE APPLICATIONS INFORMATION SUPPORT	OR20837	ZZOTH	VG10	837	62	62	0	0	ORO	GUTHRIE E
EB2502000 SOLAR ENERGY RESEARCH AERODYNAMIC & STRUCTURAL RES	CH00178	GOL	C005	250	2,396	2,396	3,520	5,600CR	CHO	CADOGAN J
EB2502000 SOLAR ENERGY RESEARCH HYDROGEN RESEARCH	CH10093	GOL	C005	004	60	60	0	0	CHO	KLUNDER K
EB2502000 SOLAR ENERGY RESEARCH MIST BLACK COLLEGE & UNIV. SUBCT. RESEA	CH10093	GOL	C005	363	150	150	150	0	CHO	DYES O

EB25:ACTIVITY NAME: WIND ENERGY SYSTEMS

B&R NO. / CONTRACTOR NAME / DESCRIPTION OF WORK	CONTRACT NO.	CITY / STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2502000 SOLAR ENERGY RESEARCH SMALL WIND SYS DEV	CH10093	GOL CO05	705	2,860	2,860	0	0	CHO	DYES D
EB2502000 SRA TECHNOLOGIES INC. SUPPORT & SYS ANALYSIS	CE89206	ZZOTH VG10	152	175	175	200	100	WHQ	ANCONA D
EB2502000 WESTINGHOUSE ELECTRIC DOUBLY FED MACHINE/VAR SPEED APPLIC	RA50292	PIT PA09	005	149	149	0	0	CHO	ROESLER D
EB2502200 PACIFIC NORTHWEST LABS WIND CHARACTERISTICS	RL01830	PNL WA05	013	1,500	1,500	1,130	1,000	RLO	CADOGAN J
EB2502300 SANDIA LABS VAWT RESEARCH	DP00789	SANDI NM01	591	4,200	4,200	4,500	700	ALO	GOLDMAN P
EB25 ACTIVITY TOTAL				30,789	28,124	21,707	3,380CR		

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/VITY NAME: OCEAN ENERGY SYSTEMS

CONTRACT NO. / :TOR NAME / PTION OF WORK	CITY	STATE / CONG.	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	FY... B/A			
,0000 CHENG38 NNE NATIONAL LAB / EXCH MAT. RES	ARG	IL13	033	115	115	520	125		
EB2600000 CHENG38 ARGONNE NATIONAL LAB HEAT EXCHANGERS PERF.	ARG	IL13	034	873	873	300	0	CHO	KIM M
EB2600000 CHENG38 ARGONNE NATIONAL LAB ADVANCED THEORY SYS DAT.	ARG	IL13	065	115	115	130	0	CHO	KIM M
EB2600000 MA32625 CALCULON DISPLAYWRITER/PC SUPPORT	WAS	DI98	009	2	2	0	0	WHQ	BACK P
EB2600000 SF00700 ETEC CORP MATERIALS & STRUCTURAL RESEARCH	CANO	CA26	023	299	299	200	0	SFO	KIM M

EB26:ACTIVITY NAME: OCEAN ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2600000 SF00700 CANO CA26 ETEC CORP EXPERIMENTAL VERIFICATION	024	738	738	0	0	SFO	CASTELLANO
EB2600000 SF00700 CANO CA26 ETEC CORP DEOBLIGATE - STF UPGRADE	700	1,600CR	1,600CR	0	0	SFO	CASTELLANO
EB2600000 CE30784 ZZOTH V010 MERIDIAN CORP RE SUPPORT SVC (OCEAN)	007	162	162	85	175	WHQ	ROGERS L
EB2600000 CH10093 00L C005 SOLAR ENERGY RESEARCH STF UPGRADE	093	1,600	1,600	790	1,200	CHO	LEWIS L
EB2600000 CH10093 00L C005 SOLAR ENERGY RESEARCH DIRECT CONTRCT HEAT & MASS TRANSFER	155	145	145	0	0	CHO	LEWIS L

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EB26:ACTIVITY NAME: OCEAN ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2600000 CH10093 GOL C005 SOLAR ENERGY RESEARCH ALT SYS OCEAN R&D	156	134	134	253	0	CHO	RITZCOVAN
EB2600000 CH10093 GOL C005 SOLAR ENERGY RESEARCH ADV THEORY	354	925	925	130	1,000	CHO	CASTELLANO
EB2600000 CH10093 GOL C005 SOLAR ENERGY RESEARCH SCTF ENHANCE	506	465	465	790	0	CHO	LEWIS L
EB2600000 CH10093 GOL C005 SOLAR ENERGY RESEARCH ALT. OCEAN ENERGY SYSTEM	507	274	274	439	0	CHO	LEWIS L
EB2600000 CE89304 ZZOTH TN05 TENNESSEE STATE UNIV OTEC R&D(HBCU)	001	0	0	100	0	CHO	CASTELLANO

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EB26:ACTIVITY NAME: OCEAN ENERGY SYSTEMS

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB2600000 ET21039 PIT PA09 WESTINGHOUSE ELECTRIC SETTLEMENT/TERM OF CONVENIENCE	055	5	5	0	0	WHQ	RICHARDS M
EB26 ACTIVITY TOTAL		4,252	4,252	3,737	2,500		

35EB:ACTIVITY NAME: SOLAR ENERGY

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
35EB25000 TBD0000 PHL HA05 INTERNATIONAL BUS MACH RE PERSONAL COMPUTERS	010	3	3	0	0	WHQ	BUDZICH R
35EB25000 TBD0000 PHL HA05 INTERNATIONAL BUS MACH MICROCOMPUTER EQ	012	21	20	20	0	WHQ	CADOGAN J
35EB25000 BP08789 ALBU NM03 SANDIA LABS MIND SUPPORT EQUIPMENT	035	88	88	195	70	ALO	GOLDMAN P
35EB25000 CH08895 GOL CO05 SOLAR ENERGY RESEARCH MIND CAP EQ	015	88	88	459	100	CHO	CADOGAN J
35EB ACTIVITY TOTAL		200	199	674	170		
DIVISION TOTAL		35,241	32,575	26,118	710CR		

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DEPUTY ASSISTANT SECRETARY

FOR

ALCOHOL FUELS

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REPORT CIS14332

U. S. DEPARTMENT OF ENERGY
DIRECTOR OF ALCOHOL FUELS
OFFICE OF ALCOHOL FUELS
DIVISION OF ALCOHOL FINANCIAL ASSISTANCE

FY 86 MULTI YEAR PLAN
AS OF : 03/15/86

E&SA-ACTIVITY NAME: ALCOHOL FINANCIAL ASSISTANCE

SAS NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 $/A	AUTHORIZED FY-85 $/A	PLANNED FY-86 $/A	PLANNED FY-87 $/A	AWARD OFFICE	PROJECT MANAGER
CHANDLER CHEMEX SAN DIEGO NATIONAL LAB ENVIRONMENTAL SUPPORT ACTIVITIES	001	0		100	100	ORO	VOORHEES M
PETERSBURG TETRADE T L CORPORATION TECHNICAL REVIEW LOAN APPLICATIONS	001	45		0	0	NRO	VOORHEES M
PETERSBURG CRISPY TOMATOES VALLEY DATA ENVIRONMENTAL PURSUND-ALCOHOL FUELS	002	000		000	0	NRO	VOORHEES M
CRISPSBURG TOMATOES ITO TORZ E & A C INC TECHNICAL SUPPORT OF ALCOHOL FUEL PROGR	001	10		10	0	IRO	BECKMAN D
PETERSBURG CRISPY TOMATO CTL DRUMS LTD ENVIRONMENTAL EVALUATION & SUPPORT	001			60	0	IRO	VOORHEES M

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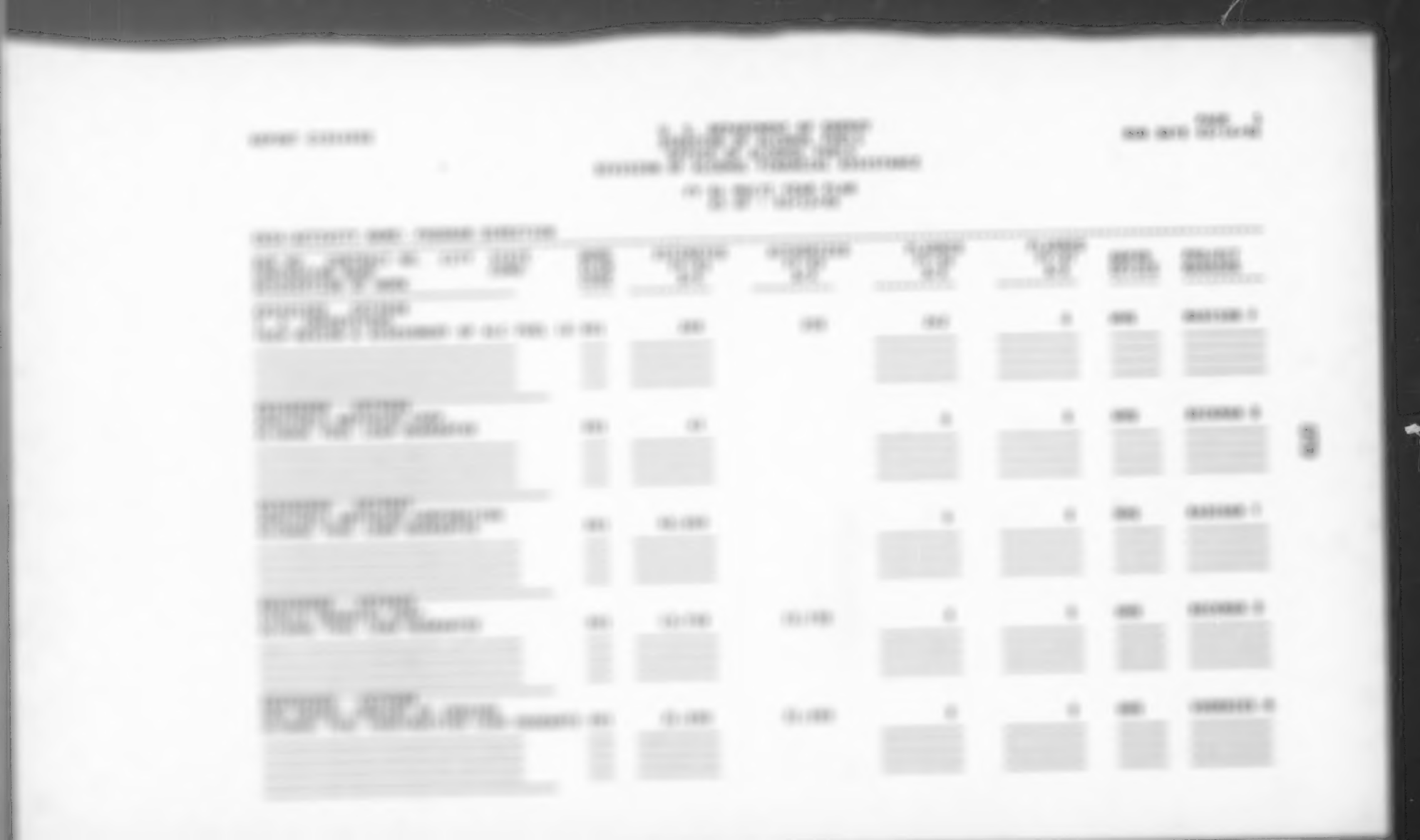
MAJOR ACTIVITY NAME: PROGRAM DIRECTION

MAJOR OBJECT CLASS / CONTRACT NO. / DATA TYPE / PROJECT NUMBER / ACTIVITY NUMBER OF WORK	PERIOD FUNDED	OBLIGATIONS INCURRED FY-83 $-K	OBLIGATIONS INCURRED FY-83 $-K	PLANNED FY-84 $-K	PLANNED FY-85 $-K	PERIOD OF FUNDS	PROJECT PERFORMANCE
25 OTHER SERVICES / 1300 CONTRACT SERVICES / 1310 / 1312 / 1313 / 1314 / 1315 / 1316 / 1317 / 1318 / 1319 / 1320 / 1321 / 1322 / 1323 / 1324 / 1325 / 1326 / 1327 / 1328 / 1329 / 1330 / 1331 /



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EB34:ACTIVITY NAME: ALCOHOL FINANCIAL ASSISTANCE

B&R NO. CONTRACT NO. CITY STATE CONTRACTOR NAME CONG. DESCRIPTION OF WORK	WORK ELEM CODE	ESTIMATED FY-85 B/A	AUTHORIZED FY-85 B/A	PLANNED FY-86 B/A	PLANNED FY-87 B/A	AWARD OFFICE	PROJECT MANAGER
EB3402000 CE79004 NEW ENGLAND ETHANOL, INC. ALCOHOL FUEL LOAN GUARANTEE	001	58,900	58,900	0	0	WHQ	BECKMAN D
EB3402000 GC30472 RFP SUPPORT SVCS/LEGAL/ALCOHOL FUEL LOAN GU	001	213	0	0	0	WHQ	OLIVER L
EB34 ACTIVITY TOTAL		138,045	96,674	1,734	100		
DIVISION TOTAL		138,045	96,674	1,734	100		

SOLAR BUILDINGS ENERGY SYSTEMS

Mr. Bevill. What specific projects will be undertaken in this activity in FY 1987?

Miss Fitzpatrick. Planned FY87 activities fall into a number of categories. In materials research, work will continue in optical switching and aerogel glazings, low-emissivity coatings, and daylight-enhancing materials. Thin-film ploymer solar collector materials research will investigate possibilities for medium-temperature applications. Research will continue on advanced Compound-Parabolic-Concentrator collector configurations, and on solid state phase change materials for thermal storage. Systems research will include testing of experimental open-cycle absorption chiller cooling systems. Development will continue of analytical tools for the understanding of the operation and performance of solar systems when integrated into buildings. Advanced systems concepts for residential and non-residential buildings will also be studied.

Mr. Bevill. Provide for the record a list of all projects, contracts and activities undertaken in this activity in FY 1985 and 1986.

Miss Fitzpatrick. A list of solar buildings energy systems projects, contracts and activities to be undertaken in FY 1985 and FY 1986 will be included in the overall list of solar and renewable projects being covered in another question.

Mr. Bevill. Describe what is meant by the following and indicate where this will be done and how much will be spent in FY 1987"

"Systems research and development (nonresidential buildings). Research directed at providing the buildings industry with practical heating, cooling, and daylighting solutions for non-residential buildings, in which practitioner confidence is effected through adequate documentation of predictability and proven performance. This would facilitate implementation of these technologies by the buildings industry."

Is this a new activity in FY 1987?

Miss Fitzpatrick. This is not a new activity. This is a continuing part of the Solar Buildings Program. Systems research involves the development of technical information which reflect the interaction and effectiveness of diverse materials, equipment, and systems,employed as solar technologies in different non-residential buildings. Building owners, designers and engineers require the means for accurately predicting solar energy contributions when they select systems for specific buildings. Inasmuch as no two buildings are alike in function, size, configuration and site, micro-climate, conditions, the data and guidelines resulting from this research are essential for employing solar systems with which they are currently unfamiliar.

PHOTOVOLTAICS

Mr. Bevill. What university research and training activities will be done in FY 1987? Provide a list of each university research and training grants done in FY 1985 and FY 1986.

Miss Fitzpatrick. Over $8.7 million or 20% of the FY 1985 Photovoltaic budget went to support research at forty universities and colleges. The highlights of this effort include a new three year effort at five universities to support basic research and at the same time train graduate students. Five awards in new ideas went to universities. Ongoing efforts at such universities as Harvard, Southern Methodist, Purdue, and North Carolina State lead research in theory and characterization of thin films. The Institute for Energy Conversion of the University of Delaware is at the forefront of photovoltaic chemical engineering processes. From the research supported by the DOE, the Institute assists industry in their individual process engineering problems.

A university program similiar to that of FY 1985 is underway for FY 1986 and will continue to be a high priority in FY 1987, particularly that associated with investigating the basic science of photovoltaics. A listing of universities currently involved in DOE supported photovoltaic research follows:

Brown University

California Institute of Technology

City Univeristy of New York

Clemson University

Colorado State Univeristy

Cornell University

Harvard University

Iowa State University

Massachusetts Institute of Technology

New Mexico State Univeristy

North Carolina State University

Pennsylvania State Univeristy

Polytechnic Institute of New York

Purdue University

Rensselaer Polytechnic Institute

Rutgers University

Southern Methodist University

Stanford University

State University of New York at Buffalo

Texas Tech Univeristy

University of California at Los Angeles

University of California at Santa Cruz

University of Delaware - Institute of Energy Conversion

University of Florida

University of Illinois at Chicago

University of Kentucky Research Foundation

University of Oregon

University of Pennsylvania

University of Southern California

University of Texas at Arlington

University of Toronto

Univeristy of New South Wales

University of Utah

University of Washington

Washington University at St Louis

Howard University

Mr. Bevill. What will be done to ".....promote the development of new ideas"?

Miss Fitzpatrick: It is expected that new ideas development will come from the following: continuation of the university program, workshops and technical symposia, and unsolicited proposals as well as, an outgrowth of continuing laboratory and industry research.

Mr. Bevill. What documentation, workshops and technical symposia were held in FY 1985 and are planned for FY 1986? How much is requested for this in 1987?

Miss Fitzpatrick. At least Quarterly and Annual Reports are prepared from all contractors and subcontractors. Also, proceedings are produced for all program integration meetings, workshops, symposia and subcontractors reviews.

In FY 1985 the following workshops and technical symposia were held: JPL/FSA - Program Integration Meeting #25, Sandia - Systems Program Integration Meeting #6, Sandia - Concentrator Program Integration Meeting #13, SERI - 6th Annual Advanced R&D Meeting, Measurements Workshop, Reliability Workshop, Amorphous Silicon Subcontractors Annual Review, and FSA Workshop on Crystal Growth for High Efficiency Silicon Solar Cells.

In FY 1986 the following workshops and technical symposia were held or are expected to be held: JPL/FSA - Program Integration Meeting #26, Sandia - Concentrator Program Integration Meeting #14, PV Annual Systems Symposium, University Grants Workshop, SERI - 7th Annual Advanced R&D Meeting, Conference on Ternary and Multinary Semiconductors, PV Safety Workshop, Silicon Stress/Strain Workshop, and Silicon Module Reliability Workshop.

Funds for FY 1987 workshops and symposia are contained within the individual program elements and are approximately $100,000.

Mr. Bevill. Describe the ".....cost shared program for the advancement of the scientific based in amorphous silicon-based alloy materials." Who are the cost shared partners and how much will they contribute? How much is requested in FY 1987 for this?

Miss Fitzpatrick. Four major amorphous silicon contracts, for three years each, are running simultaneously. The four subcontractors are: Chronar, Solarex, 3M, and Spire. Each contractor is cost-sharing, with

the DOE paying 70% and the contractor paying 30% of the costs. Thus, DOE has paid approximately $3,500,000 and the subcontractor has paid approximately $1,500,000 for each of the three year contracts. All four contracts are now entering their third and final year. All contractors are meeting the objectives of their contacts.

A new solicitation has been issued for advanced work in the technical area in FY 1987 which will require at least 50% cost-sharing by the winners. Approximately $3,000,000 of FY 1987 funds requested will be used for these new contracts.

SOLAR THERMAL ENERGY SYSTEMS

Mr. Bevill: How will the three collaborative activities be continued in FY 1987? With whom? How much is requested for this?

Miss Fitzpatrick: No funding has been requested in the President's FY 1987 budget for continuation of the three cooperative agreements. Southern California Edison, Pacific Gas and Electric, and Arizona Public Services are expected to be the principal organizations to perform the studies. In FY 1986 the Department will ask for proposal revisions from the appropriate organizations. Funding requirements, if any, are not known at this time.

Mr. Bevill: What testing will be done at Barstow in FY 1987?

Miss Fitzpatrick: Solar One was turned over to a consortium of utilities led by Southern California Edison to operate as a utility in a power production mode in August 1984. The third and final year of operation will be completed in FY 1987 (August 1, 1987).

Mr. Bevill: What results has Barstow achieved to date?

Miss Fitzpatrick: Solar One is operating more efficiently each year of its operation in the power production mode. In the first year of utility power operation, a total of slightly over 7000 MW hrs were produced. The current production is running about 50% higher than the previous year. On winter soltice, December 20, 1985, the power production for that day exceeded the goal established by 12%. A utility program to enhance the reliability of heliostat operation (99% availability) and increase the absorptivity of the receiver (painting the panels) was eminently successful, and contributed to the reasons for achieving the higher power ratings. Recent operation (February 26, 1986) established an all time peak power output for operating in the receiver only mode at 11.7 MWe net. Positive net electric outputs were achieved during all the most recent winter months. The following records have been acheived at Solar One:

- Production of 43.8 MWe hrs net from thermal storage (requirement 28 MWe hrs) (5/83).
- Longest operating day - 15 hrs. (6/83)
- Maximum Energy production day - 82.6 MWe hrs (6/85)
- Maximum Energy production month - 1775.8 MW hrs (8/85)

BIOFUELS ENERGY SYSTEMS

Mr. Bevill. The justification material submitted in support of the biofuels energy system's budget request of $15,126,000 is incomprehensive and incapable of providing any reasonably intelligent layman with an understanding of the objectives of this research program and the details and requirements for funding. It does not justify the requirement for funding. Provide a description of this program that does this.

Miss Fitzpatrick. Biofuels represents an extremely broad field of technology involving complex tradeoffs among various feedstocks such as municipal wastes, woody and herbaceous biomass, or algae; and alternate methods for converting the various organic components of these feedstocks into valuable energy commodities such as gaseous or liquid fuels. Each scientific and technical field of view within biofuels is therefore perhaps as complicated as any other single area of energy technology, and research requirement descriptions in budgetary statements can lead to understandable difficulties in interpretation.The DOE FY 1987 budget request of $12,200,000 is reasonably balanced between research directed at improving the characteristics of feedstocks, and research directed at defining the process dynamics associated with the priority biochemical or thermochemical methods for producing fuels from these feedstocks. For each combination of feedstock and conversion technology, specific research objectives have been established and provide the basis for evaluating progress and determining tradeoffs

among technical priorities. In general, successful accomplishment of these objectives would lead to viable gaseous fuels from the woody and herbaceous feedstocks within the mid-term, alcohol fuels from woody biomass in the longer term, and petroleum-like fuels from microalgae in the very long term. DOE staff are available to brief Committee staff on program strategy and objectives at the Committee's request.

Mr. Bevill. Why, after eight years of DOE research, is it necessary to establish an effort to examine the "basic science of wind turbine dynamics"?

Miss Fitzpatrick. More basic research is required because that is where the break-throughs must be found. There is a need for improvement in today's technology. Performance of windfarms using "good" turbines is sometimes 50 to 75 percent of what was predicted. Turbulence in the input wind has proved to be a major factor in stress of rotor blades and resulting fatigue life. With current technology and design tools, rotors on some commercial turbines have unexpectedly experienced only a 2 to 5 year lifetime.

The Wind Five Year Plan sets a goal of improving energy capture by a factor of two and structural life by a factor of 5 to 10. These are tough goals that we are pursuing in two interacting parallel activities: First, the Science of Wind Turbine Dynamics which is aimed at improved understanding of the interaction of the wind with the airfoil producing both mechanical energy and structural stress. From this will come improved computer models to design airfoils, reduce stress and predict fatigue life. Second, Advanced Components and Supporting Research, in cooperation with industry is aimed at proof-of-concept technology development in advanced airfoils, generators, control systems and supporting activities such as environmental impacts and utility interactions. Industry can then apply these concepts in commercial ventures, if they choose.

Mr. Bevill. What improved understanding, for example, of the "local behavior of the wind", is to be found?

Miss Fitzpatrick. Local behavior of the wind refers to changes in wind direction and speed over relatively short distances, say between adjacent turbines in an array, due to the influence of terrain and other local factors. This variability means that two adjacent turbines may differ in loads or energy production by factors of two or more and is a real problem for wind farmers. Cooperatively with industry we are working to validate, extend and disseminate mathematical and physical models to address this problem.

Mr. Bevill. What is the current status of the Boeing Mod-5B program?

Miss Fitzpatrick. The Mod-5 design is complete. Fabrication and assembly of the machine is nearly done with shipment to the site in Hawaii originally scheduled for April 1986.

Mr. Bevill. What is the current total project cost of Mod-5B?

Miss Fitzpatrick. Completion of the entire Mod-5B program, including industry and government share, is estimated to cost $74.8 million.

Mr. Bevill. What is the current estimated hardware cost?

Miss Fitzpatrick. $12 million.

Mr. Bevill. What is the remaining cost to complete?

Miss Fitzpatrick. The Government share would be $16.2 million (minus $4 million eventual repayment for the machine) and Industry, $4.2 million.

Mr. Bevill. How much as been invested in the Mod-5 program to date? In Mod-5B?

Miss Fitzpatrick. Through FY 1985 the government has invested about $81 million in the Mod-5 program including the GE (Mod-5A) & Boeing (Mod-5B) contracts and NASA research and supporting development testing. NASA costs including related research and testing total about $11 million. The Mod-5B contract with Boeing is funded up to $42 million to date.

Mr. Bevill. What difficulties have been experienced in Mod-5B in FY 1985?

Miss Fitzpatrick. Design of the Mod-5B program has progressed smoothly. There have been some cost increases due to delays in some hardware delivery, but this is primarily under the Firm Fixed Price part

of the contract. The usual kinds of development problems are anticipated, but they are not expected to be major because of the experience base developed on Mod-2.

Mr. Bevill. How much has been invested by Hawaiian Electric?

Miss Fitzpatrick. Approximately $1.7 million.

Mr. Bevill. What contractual obligation does DOE have to contractors to pay tooling or other closeout costs for Mod-5B?

Miss Fitzpatrick. The contracted amount with Boeing is $42,050,000 which includes all of their subcontracts for things such as hardware and tooling. Under the current contract, expenditures in excess of that amount are not authorized and that would include any closeout costs.

Mr. Bevill. How does the Department view the international potential for sales of wind energy equipment, and what is it doing to ensure that the U.S. is competitive in the world market?

Miss Fitzpatrick. Although 85 percent of the world market for wind energy equipment is now in the U.S., there is vast potential for remote power sources all over the world (37 gigawatts, according to Frost and Sullivan). In seeking international sales, however, U.S. companies will encounter very heavy competition from European and Far Eastern wind turbine manufacturers. In addition, most U.S. wind manufacturers are small businesses, with little experience in exporting.

To help U.S. companies better compete in the world arena, DOE has sponsored two Export Seminars for the wind industry, in March 1985 in Washington and last month at a conference in New Orleans; held a wind/diesel workshop (for remote applications) at SERI last June; and established the Committee on Renewable Energy Commerce and Trade whose purpose it is to foster the export of renewable energy products.

We also work with the Department of Commerce to co-sponsor trade promotion events which are cost-shared by U.S. renewable energy companies. This includes the RETSIE conference in California which stresses bringing potential foreign buyers to the U.S. to see American Renewable Energy products in use.

Mr. Bevill. Could you describe the efforts that the federal wind energy research program is making to ensure input from industry into directions for future research?

Miss Fitzpatrick. When we began formulating our most recent 5-Year Research Plan for wind energy in 1984, DOE held three public meetings with the wind industry around the country to obtain their input. Later, we circulated the draft plan to everyone who attended those meetings, plus others who couldn't be there.

Last August DOE and the American Wind Energy Association jointly sponsored "Wind Power 85" a technical conference attended by 600 people from the wind community.

In January of this year, the board of the AWEA met with our wind researcher at SERI. Both sides considered the talks very constructive and helpful to our future planning.

Mr. Bevill. How strong, in the Department's view, is the research capability that exists in the private wind energy industry?

Miss Fitzpatrick. Generally, the wind industry is composed of a few large companies and small businesses with limited capabilities to pursue the necessary research in these fields. The large companies have a moderate research capability; the small ones vary, but the better ones have testing and evaluation capabilities. As a result of the wind farm development, the primary focus of industry interest is in developing 100-1000kW intermediate machines. Some small manufacturers entering in the intermediate wind turbine business do not have needed research capabilities nor test facilities and rely on DOE for support. Major technical questions exist with regard to intermediate horizorital and vertical axis systems, and there exists very little experimental and operating data. Primary concerns are loads associated with air turbulence, induced vibration, and structural dynamics. This is coupled with uncertainties regarding fatique life/material failure and ultra high cycle limits. These factors combine to create many uncertainties in design requirements, weight, cost estimates, lifetime and safety. DOE plans are aimed at reducing these risks.

OCEAN ENERGY SYSTEMS

Mr. Bevill. How much of the FY 1987 budget request is for closed-cycle research?

Miss Fitzpatrick. None. With DOE support, a preliminary design of a closed cycle system has been completed and organizations in the private sector are considering further development of such a plant. The entire Ocean Energy budget for FY 1987 will be dedicated to open-cycle OTEC research and facilities expansion for open-cycle experiments, since less work has been done in this area. Some generic research is applicable to both types of cycles.

Mr. Bevill. How do the economics of ocean energy research change when you include production of fresh water in addition to electricity generation?

Miss Fitzpatrick. Two methods of fresh water production are possible from the Ocean Thermal Energy Conversion (OTEC) process. One method uses a surface condenser in the open cycle power system to condense the steam created in a vacuum in the evaporator into fresh water after that steam has driven a turbine. The second method, applicable to either open or closed cycle, passes the cold water effluent exiting the power system through a second surface condenser. Since OTEC is located on the ocean or its shore, the air is humid. Blowing the air over the condenser cooled by the cold water effluent produces both fresh water and cold, relatively dry air (air conditioning).

For either method, a potential decrease of 25% to 75% in the cost of OTEC electricity is projected from fresh water sales.

Mr. Bevill. With no demonstration project in planning for ocean energy systems, what is the technology development effort intended to support?

Miss Fitzpatrick. DOE's Ocean Energy program is performing research on key ocean energy technology issues to a point where the commercial sector can make knowledgeable assessments of whether commercial applications of the technology are viable. That would be the appropriate time for the private sector to decide if demonstration or commercialization is appropriate.

Mr. Bevill. What work is being done at the Seacoast Test Facility?

Miss Fitzpatrick. In FY 1986, heat exchanger experimental research is being conducted for both direct contact evaporators and surface condensers. Design and preparation work for open cycle experiments will continue. Biofouling, materials and waterside enhancement tests under OTEC operating conditions will be completed.

To accommodate the planned experiments, DOE together with the State of Hawaii is in the process of upgrading the capability of the STF. This upgrade will increase access to the cold and warm water supply, install a spent water system, increase the experimental capabilities and provide an environmental assessment to ensure minimal environmental impacts.

INTERNATIONAL SOLAR PROGRAM

Mr. Bevill. Why were the FY 1986 funds for the international solar program deferred?

Miss Fitzpatrick. Except for the $200,000 FY 1986 Budget Authority retained by DOE, prior year funds are sufficient to maintain progress in this program. These funds will support: the long-standing export promotions programs at DOE; a joint education program with AID, under one of the subcommittees of CORECT; a joint effort with the World Bank to assess potential for wind farms in selected countries; and industry liaison efforts, through the Renewable Energy Institute.

Mr. Bevill. Provide a list of all international conferences and other activities supported in FY 1986 by the solar international program.

Miss Fitzpatrick. The major international conference in FY 1986 will be RETSIE--the Renewable Energy Technology Symposium and International Exposition in Anaheim, California. Through DOC, we sponsored a successful photograph exhibit of U. S. renewable energy products in Manila, Phillippines during November 1985. In addition, we and DOC have two video tapes on U. S. companies which have been screened in some 50 countries.

In August 1985 we supported a major Renewable Energy conference and exhibition in Beijing, China, and Commerce plans several trade events for the remainder of FY 1986 (Tunisia, Morrocco, Algeria, Greece, Rumania, Cyprus).

SOLAR TECHNOLOGY TRANSFER

Mr. Bevill. Why has the Administration reduced its request for funding for technology transfer activities in FY 1987?

Miss Fitzpatrick. The technology transfer line item provides for publication of technical reports for the R&D community, operation of referal services for scientific as well as public inquiries, and responding to general requests for information. As such, the technology transfer activities funded within this area reflect the needs of the programs as proposed.

Mr. Bevill. Provide for the record a list of all activities funded under the technology transfer program in FY 1985 and planned for in FY 1986?

Miss Fitzpatrick. The types of activities funded in FY 1985 and FY 1986 will be continued in FY 1987. These activities include: Development and publication of technical reports and research products (SERI); operation of the technical inquiry and referral service (SERI); development of the R&D exhibit for the annual Renewable Energy Technology Symposium and International Exposition exhibition (SERI); and operation of the Conservation and Renewable Energy Information and Referral Service (CAREIRS) for responding to general information requests.

Mr. Bevill. What are the "mainline technical and public information services" and what is meant by "low visibility reactive mode of operations"?

Miss Fitzpatrick. This phraseology means that each of the major activities identified in response to the preceeding question will continue within the FY 1987 program at a level of activity consistent with the reduced levels of requested funding. Important information will continue to be available to technical or general inquiries.

GEOTHERMAL PROGRAM

Mr. Bevill. What is the current status of geopressure well activity? How many wells are now in use and how many are planned in FY 1987?

Miss Fitzpatrick. Currently, there is one geopressure design well in operation, the Gladys McCall well south of Lake Charles, LA. The other design well, the Pleasant Bayou well south of Houston, TX, is undergoing repair prior to testing of a new power generation concept in cooperation with EPRI. One other geopressure well, the Willis Hulin well near Lafayette, LA, is in standby pending a final decision on its future use. In FY 1987, we plan to operate both the Gladys McCall and the Pleasant Bayou wells.

Mr. Bevill. What additional data can be gathered from these test wells?

Miss Fitzpatrick. The most important information needed by industry before a decision can be made to undertake commercial development of geopressured reservoirs is the long-term performance of such reservoirs. Both the Gladys McCall and Pleasant Bayou reservoirs have been shown to be very large in area extent, but the forces which maintain pressure in the reservoirs are poorly understood, so prediction of performance awaits the results of the present test program. In addition, the combined recovery of thermal and chemical energy as well as electricity at Pleasant Bayou is of great interest to the electric utility industry for possible use of geopressured resources for power generation as well as a valuable source of natural gas.

Mr. Bevill. How long will completion of a desired test program take and how much will it cost?

Miss Fitzpatrick. We expect to complete the needed test program in FY 1989. The current level of funding will permit the orderly completion of the program.

Mr. Bevill. What research effort will be done in FY 1987 to address uncertainties in reservoir longevity?

Miss Fitzpatrick. The question of the predictability of reservoir life is central to geothermal energy development. In geopressured resources, design well flow tests are explicitly directed toward answering that question. In hydrothermal reservoirs, the question involves a variety of issues such as the proper placement of injection wells to maintain field pressure and to prevent rapid cooling of the production wells through short-circuiting. Detailed studies of existing commercial geothermal reservoirs in Mexico, Italy, New Zealand, and Iceland have aided the development of mathematical models which predict changes in reservoir temperatures and pressures. Developing new methods of detecting fractures in reservoirs may allow recompletion of older wells and rejuvenation of geothermal fields. Improved use of microseismic data may allow the broad outlines of geothermal reservoirs to be better defined both horizontally and vertically. Finally, the very important research at the Salton Sea Scientific Drilling Project well will help us to understand the origin of hydrothermal reservoirs.

Mr. Bevill. Where and how will this be done?

Miss Fitzpatrick. I have earlier described the geopressured well tests which are designed to obtain reservoir longevity data. Injection experiments using tracers and other detection techniques are planned at several locations in the Imperial Valley of California. Commercial reservoir data collection will continue at several foreign sites, but especially in Mexico where we anticipate an extension of a cooperative research agreement which has been mutually beneficial in the past. Fracture detection is being attempted by the development of high-temperature, miniature radar units capable of operating in geothermal wells. Vertical seismic measurements have been made at The Geysers in northern California and at new fields in northern Japan to attempt to predict the most productive zones in those fields. Finally, the Salton Sea Scientific Drilling Project has already encountered two extensive reservoirs and an igneous dike, an example of the ultimate heat source of the reservoir. Research in FY 1987 is expected to add significantly to our ability to predict and improve the useful life of geothermal reservoirs.

DEEP UNDERWATER CABLE PROJECT

Mr. Bevill. What is the status of the deep underwater cable project? Why are no funds included in the FY 1987 budget for it? What remains to be done?

Miss Fitzpatrick. The project consists of a cost, no-fee contract of $16.6 million with the Hawaiian Electric Company (HECO) and a cost-plus- fixed-fee support contract of $1.66 million with the VSE Corporation. To date, $9.35 million has been obligated to the prime contract and $1.4 million obligated to the support contract. The goal of the project is to determine the technical feasibility of establishing a direct current transmission cable system between the Hawaiian Islands of Hawaii and Oahu. Substantial progress has been made toward determining the technical feasibility of the cable system: a candidate cable design has been selected, a model candidate cable is being fabricated for laboratory design verification tests, conceptual design studies for the cable handling equipment and cable laying vessel have been completed, and preliminary routes for the crossing of the Allenuehaha Channel (the most difficult part of the route) have been chosen. DOE is currently reviewing several contract options for completing the project. The review is deliberate and thorough. DOE believes that the present funding will go a long way toward the determination of the technical feasibility of a deep water cable system for interconnecting the Hawaiian Islands of Hawaii and Oahu. Consequently, DOE has not requested FY 1987 funds for the cable project.

ELECTRIC FIELD EFFECTS PROGRAM

Mr. Bevill: What research is being done under the electric fields effects program? What capability does DOE have in this area?

Miss Fitzpatrick: The research in the Electric Field Effects program will continue to establish an objective scientific data base for a.c. and d.c. electric and magnetic field effects. The a.c. Biological Research will continue to determine and analyze the effects of a.c.-induced magnetic fields upon humans. Research continues in the second year of the three-year joint DOE/Japanese project to determine the impact of exposure to high voltage electric fields upon nonhuman primates. Risk analysis methodology will also continue in FY 1987. The d.c. Biological Research in FY 1987 will consist of efforts to identify mechanisms interacting with the human respiratory system and to investigate the impact of d.c. magnetic fields. The capability of DOE in this area is complemented by expertise in a support contract, peer-review team, and rigid monitoring of all contracts.

RELIABILITY R&D

Mr. Bevill: What work remains to be done in Reliability R&D in the electric ~~energy~~ systems program?

Miss Fitzpatrick: Reliability research will consist of EMP Impact Analysis and Normal/Emergency Operating Concepts. In the EMP area, research will continue on the second-level impacts assessment of potential system damage. The assessment will draw heavily upon data obtained in FY 1986. EMP research on developing hardening and assessment options will be considered in future budget years. The Normal/Emergency Operating Concepts research will focus on the development of advanced microprocessor computer technologies and on-line stability and recognition concepts.

SUPERCONDUCTING TECHNOLOGY

Mr. Bevill: Discuss the research that needs to be accomplished for integrating superconducting technology into an existing utility network.

Miss Fitzpatrick: The superconducting power technology projects will be completed in FY 1986 with the determination of the technical feasibility of the 138 kV, 1GW superconducting transmission cable (Brookhaven National Laboratory) and the 10 MVA advanced concepts synchronous generator (MIT). These concepts will be transferred to the private sector for further development and commercialization. Recent industry surveys revealed that the utilities do not anticipate any applications for relatively high power density superconducting power equipment until the second decade of the 21st century. Major reasons for postponing the integration of superconducting equipment into utility networks are primarily economic concerns about relatively high capital costs and long-term reliability.

STATUS OF DOE BATTERY RESEARCH WORK

Mr. Bevill. What is the status of DOE battery research work?

Miss Fitzpatrick. The DOE battery research program is intended to extend the knowledge of electrochemical concepts to improve the storage of electrical energy over the next decades. DOE has a broad program in basic electrochemical energy storage which is focused on understanding basic phenomena, developing and identifying new materials, components, and designs which would have the potential for very low cost production while maintaining high performance, and investigating advanced battery concepts which could substantially advance the state-of-the-art. Applied research activities are focused on developing the sodium-sulfur technology to allow the fabrication of laboratory-scale modules to allow the proving of reliability and performance.

DEFERRAL OF ZINC-BROMINE BATTERY FUNDS

Mr. Bevill. Why were the zinc-bromine battery funds deferred?

Miss Fitzpatrick. The original President's Budget proposed $200,000 for zinc-bromine battery research. Congressional mark-ups added $1.5 million to the original budget for this purpose. With the Federal deferral of FY 1986 funding, this was one area where higher priority work received preference. This is true in FY 1987 also, where no funds are being requested.

ADDITIONAL QUESTIONS FOR WIND ENERGY

Mr. Bevill. What are the existing contractual arrangements for the development and operation of the Mod-5B prototype?

Miss Fitzpatrick. Boeing is undercontract to NASA to design, build, install and test the Mod-5B. NASA has a sales agreement with Hawaiian Electric Industries, Inc. under which Hawaiian Electric agrees to purchase the machine from the Government upon successful completion of testing.

Mr. Bevill. How much money has been invested by the Federal government in the Mod-5B program?

Miss Fitzpatrick. Through FY 1985 the government has invested $53 million in Mod-5B including $11 million for NASA research and supporting development testing.

Mr. Bevill. How much has the private sector already spent or advanced toward the Mod-5B?

Miss Fitzpatrick. To date, Boeing has invested about $4 million and Hawaiian Electric about $1.5 million.

Mr. Bevill. Does this include the amounts already expended by Hawaiian Electric Industries in site preparation for the Mod-5?

Miss Fitzpatrick. That is correct. Hawaiian Electric's total site preparation cost is expected to be $1.7 million.

Mr. Bevill. We understand that fabrication of all major hardware has been completed and that construction of the tower has been accomplished on site in Hawaii. Can you confirm this status?

Miss Fitzpatrick. Fabrication of all major hardware has been completed. The tower contractor has completed erection of the steel tower.

Mr. Bevill. What is the approximate schedule required to complete assembly of the Mod-5B on-site and to obtain beneficial use of the machine?

Miss Fitzpatrick. Assembly of the machine on site was scheduled to be completed in October 1986, at which time checkout and acceptance testing would start. Acceptance testing was scheduled to be completed by mid FY 1987.

Mr. Bevill. We understand that the project is approximately 80% complete. Can you confirm this understanding?

Miss Fitzpatrick. I would agree with that estimate.

Mr. Bevill. How much do you estimate completion of the Mod-5B will cost? Please allocate those costs by fiscal year. Also indicate what the costs of acceptance testing will be.

Miss Fitzpatrick. The estimated cost to complete the Mod-5 is $16.2 million. If Congress were to overrule the FY 1986 proposed deferral, an additional $4.2 million would be required to complete the project including $2.8 million for the final inspection and acceptance testing.

Mr. Bevill. Last year the Congress rejected the Administration's proposal to terminate the Mod-5B, and instead appropriated $12 million for the program in fiscal 1986. Now the Administration has announced a deferral of $10.240 million of these appropriations. Does the Department plan to use the remaining funds to terminate the program?

Miss Fitzpatrick. The remaining funds are for Graham- Rudman-Hollings reduction of $450,000 with the balance of $1.3 million to close out of the project.

Mr. Bevill. Has the Department estimated how much it would cost the government to terminate the Mod-5B program? The current contract with Hawaiian Electric Industries, for example, requires that the government pay for restoration of the site if the project is terminated. How much will its restoration cost? Does this estimate include the $4.0 million which the government can expect to receive from Hawaiian Electric Industries to purchase the machine?

Miss Fitzpatrick. The Boeing contract has been funded only up to $42,050,000. Under the Sales agreement with HEI, DOE would remove the hardware and restore the site. Depending on how the large concrete foundation is disposed of, costs are estimated to be from $200 thousand or range up to $1 million if the foundation would have to be excavated and removed.

Mr. Bevill. Last year in testimony before this Subcommittee, you stated that the contractor's design for the Mod-5B is "considered excellent from an engineering point of view." Has your assessment of the design changed?

Miss Fitzpatrick. Our assessment of the Boeing design has not changed from last year. We still feel, based on lessons learned from the design and operation of the Mod-2's and inputs from Hawaiian Electric, that Boeing is doing a good job. The deferral is motivated by a need to fund higher scientific priorities and consideration of the likelihood of commercializing the technology, and should not be considered a reflection upon the high technical caliber of Boeing work to date.

Mr. Bevill. Do you anticipate any technical problems that would prevent completion of the Mod-5B if sufficient funding is made available?

Miss Fitzpatrick. We have no reason to believe that technical problems would effect the completion of the construction of the Mod-5B.

Mr. Bevill. Are there any significant concerns regarding the capability of the hardware?

Miss Fitzpatrick. We feel that hardware risks are moderate to low, because the design has benefitted from over extensive testing of the Mod-2's. However, we must keep in mind this would be an experimental machine with the largest rotor ever built, and there is always some possibility even if small, that some problem or failure of a part or component could occur during initial testing.

Mr. Bevill. Is the Department concerned in any way regarding the ability of the contractor, the Boeing Company, or the purchaser, Hawaiian Electric Industries, to construct and successfully operate the prototype?

Miss Fitzpatrick. Based on our experience with Boeing and the Mod-2's, and Hawaiian Electric and a previously completed program that involved the installation and operation of a Mod-OA in Hawaii, we have no reason to be concerned with either Boeing or Hawaiian Electric's ability to successfully construct and operate the Mod-5B.

Mr. Bevill. Have any significant problems in contract administration been encountered?

Miss Fitzpatrick. No significant contract problems have been experienced over the past year.

Mr. Bevill. What role have budgetary considerations played in the Department's decisions regarding the Mod-5B?

Miss Fitzpatrick. Fiscal management and budgetary constraints are a consideration in our position regarding Mod-5. In addition, there appears to be generally declining commercial interest in the very large wind turbines. Consequently we believe installing and testing the Mod-5 does not appear to be of as high a priority as other work, for the additional investment during these tight budget times.

Mr. Bevill. How then do you justify terminating the Mod-5 program now, when completion of the program is so near?

Miss Fitzpatrick. The generic research supported in our budget request is considered to be of higher priority and will benefit a broader crossection of the industry than proceeding with the installation and testing of the single Mod-5B. Priorities are set considering the potential contributions and lihelihood of commercialization.

Mr. Bevill. What benefits will the government have received for its multi-year effort and expenditures of over $70 million if the Mod-5 program is terminated now?

Miss Fitzpatrick. The value of this project will have been derived from the in depth engineering studies and detailed design of the Mod-5. This data will be available to the entire wind industry.

Mr. Bevill. What in your view are the costs associated with terminating the Mod-5B program?

Miss Fitzpatrick. The Boeing contract costs should not exceed $42,050,000. The costs of restoring the site could be $200k or as high as $1 million depending on the methods of disposing of the foundation and on the cost recovered from sale of the steel in the tower and turbine parts. We do not believe other termination costs will be necessary except to publish reports on the project.

Mr. Bevill. Does your estimate of termination costs include litigation costs should the private parties to the Mod-5B development and purchase contracts bring suit against the government?

Miss Fitzpatrick. We believe the contracts involved are explicit and clear and, consequently we do not anticipate litigation costs.

Mr. Bevill. How much do you estimate the government would "save" by terminating the Mod-5B program now?

Miss Fitzpatrick. Approximately $15 million can be saved by discontinuing the Mod-5B program now.

Mr. Bevill. The Department of Energy and NASA have entered into an interagency agreement regarding the development of the Mod-5B. Does NASA agree with the Department's decision to terminate the Mod-5B program?

Miss Fitzpatrick. NASA has responsibility for technical project management, and they are satisfied with technical progress to date. While NASA has been heavily involved in technical planning, they are not involved in the many other aspects of the wind R&D programs and therefore, would not be in a position to evaluate the overall programmatic or budgetary decisions.

SOLAR COOPERATIVE R&D VENTURES

Mr. Bevill. What criteria or program objectives would the Department consider appropriate for review of projects proposed for the new innovative cooperative R&D ventures?

Miss Fitzpatrick. As discussed in response to a previous question, the concept of DOE participation in cooperative research ventures with the private sector has a number of attractive features as an additional and possibly more effective program delivery mechanism. The Department is currently conducting a review of the various policy, legal, and financial aspects of participating in cooperative ventures with the private sector. Upon completion of the review, we intend to review our work with industry, solicit private sector interest in participating in the initiative, and obtain their comments or proposals on models for collaborative ventures.

Due to the dependency of proposal review criteria upon the types of mechanisms adopted for implementation, it is too soon to specify the evaluation criteria which would be employed for competitive selection of proposals. In general, however, proposals would be evaluated in light of the relevancy of the proposed research, the potential for meaningful technology transfer, the applicability of the research to the industry as a whole, and the cost effectiveness of specific offers.

Mr. Bevill. Dr. Trivelpiece, the justification material for magnetic fusion says " . . . international collaboration is being used as a key resource to support achievement of the program goal in a timely fashion." What, specifically is meant by this?

Dr. Trivelpiece. International collaboration is an integral technical and financial part of the U.S. fusion program's effort to achieve its goal to establish the scientific and technological base required for fusion energy. By utilizing international collaboration, the program should be able to attain this goal many years sooner than it would by using solely domestic resources.

Mr. Bevill. What program activities will be involved in this foreign collaboration? What countries are involved?

Dr. Trivelpiece. Several collaborations are already in place; others are being discussed. The scope of the collaboration extends to both physics and technology. Nearly all our collaborations involve the European Community and/or Japan. Examples of collaborations include: physics for the tokamak and supporting concepts, superconducting magnets, materials development, specialized tritium handling components and blanket and shield technology. New collaborations are being discussed in areas such as burning plasmas. A complete list of our present collaborations and cooperations as well as those being discussed can be found in the DOE document "International Program Activities in Magnetic Fusion Energy" which is being prepared and will be provided shortly to the Congress.

Mr. Bevill. What reciprocal arrangements do the foreign countries have to cooperate with us?

Dr. Trivelpiece. Under formal agreements identifying mutual benefits, other countries contribute money and people to enhance U.S. facilities. Examples of such reciprocal agreements are RTNS-II with Japan, HFIR/ORR with Japan, Doublet-III with Japan, Large Coil Test with the European Community, Japan and Switzerland, and numerous long term personnel exchanges to the U.S. with the European Community and Japan.

Mr. Bevill. What is the total value or cost to the U.S. of these collaborative arrangements?

Dr. Trivelpiece. The U.S. has received from Japan nearly $90M for work in the U.S. Another major value is derived from the high leverage the arrangements provide to the U.S. for access to major facilities abroad which have no counterpart in the U.S. For our investment of a few million dollars in a component, for example, we are allowed to have access to experimental programs of facilities costing hundreds of millions of dollars for work which is useful for resolution of key U.S. program issues. This access saves the U.S. the cost of building similar facilities here. Our scientists and engineers benefit from exposure to the ideas and methods employed by our partners. When they return to their home institution, these ideas and methods can be utilized in our program.

Mr. Bevill. What is the value or cost of the reciprocal arrangements being provided to the U.S.?

Dr. Trivelpiece. The primary value is that necessary work on the key fusion issues can be done quicker and cheaper, such as that done on

Doublet-III, RTNS-II, and MFTR/ORR. In some cases the work could not have been done without collaboration due to the high budget impact of a solely domestic effort, such as in the case of the Large Coil Test. In the process of doing the collaborative work, we learn from others which enables us to save development costs in some instances such as at the Tritium System Test Assembly facility. The cost to the U.S. for these benefits is minimal since our partners pay for services provided and absorb the personnal costs of their technical people while they are detailed in the U.S.

Mr. Bevill. If $333 million is a level of resources "required to sustain an effective program," what is the level below which you can not do so?

Dr. Trivelpiece. Given the goals and milestones of the current program plan, I believe that the $333 million is the minimum level of funding required to carry out an effective program. Difficult decisions have had to be made over the last two years in arriving at this level, and I believe any further reductions would jeopardize our ability to maintain progress. Our credibility as a strong and reliable international partner has already been damaged by the reductions made so far. This impairs our ability to make new agreements that might be of interest and benefit to the United States.

Mr. Bevill. In examining the budget request for FY 1987 (on page 95 of the justification material), it appears that the only area of increase is in "Program Direction" line item. Why is it necessary to maintain the relative same level of support for a program that has decreased nearly $100,000,000 or 22% in two years?

Dr. Trivelpiece. I believe that during the two year period that you mentioned--FY 1985 to FY 1987--the Program Direction amount is down by $200,000 and the actual number of FTE's is down four from 66 to 62. This decrease has come at a time when the actual workload has been increasing due to, among other things, increased international coordination activities. These include major hardware cooperation programs with Japan and the European Community involving tens of millions of dollars annually and hundreds of scientists. The actual expenditure level for this account in the period 1985 through 1987 is expected to remain essentially level.

Mr. Bevill. Provide for the record a list of FY 1986 actual and 1987 planned funding for each university in the university program and describe briefly what each university is doing and what accomplishments each has made.

Dr. Trivelpiece. University based research is a key component of the fusion program, including activity in virtually every area of fusion research, carried out at over 30 universities. I will provide for the record information summarizing the activities and recent accomplishments of each university funded directly by the Office of Fusion Energy. Direct university funding totals $46,837,000 in FY 1986. In addition to direct funding, a small number of contracts are let to universities by national laboratories either on behalf of the Office of Fusion Energy or in direct support of the laboratories' missions. Through their research activities, the universities also provide scientific manpower training critical for fusion and other research programs.

(The information follows:)

UNIVERSITY FUSION RESEARCH

	FY 1986 Estimate ($000)	FY 1987 Estimate ($000)	Activities
Applied Plasma Physics			
Auburn University	289	352	- RF modeling - RF heating in Torsatron - Diagnostics on TEXT - Electron-Impurity atomic collisions
CA Institute of Tech.	503	410	- Tokamak support experiments - Turbulence and instabilities - Transport modeling
Univ. of CA, Berkeley	184	50	- Particle codes, edge modeling
Univ. of CA, Irvine	147	120	- Auxiliary heating of plasmas by high energy ion beams
Univ. of CA, Los Angeles	2,310	2,585	- Diagnostics development, rf current drive for steady state tokamak, stability and transport in rf heated plasmas - Auxiliary heating of plasmas by ion ohmic heating - Plasma behavior, rf modeling
Univ. of CA, San Diego	240	240	- Experiments on resonant transport in simple plasmas - Transport theory
University of Colorado	60	0	- Reversed field pinch supporting concept exp.
Columbia University	931	760	- Tokamak and mirror support experiments, high beta tokamak concept development - Concept modeling
University of Connecticut	75	81	- Atomic physics theory
Cornell University	512	225	- Auxiliary heating and stabilization of compact toroid plasmas with charged particle rings - Ion beam and ring theory
Dartmouth College	60	60	- Turbulence theory
Hunter College	0	25	- Tokamak theory
University of Illinois	25	60	- Diagnostics development
Johns Hopkins University	340	350	- Diagnostics development

University of Illinois	25	60	- Diagnostics development
Johns Hopkins University	340	350	- Diagnostics development
University of Maryland	645	1,172	- Diagnostics development - Atomic physics experiments - Plasma confinement in spheromak - Nonlinear plasma theory
Mass. Inst. of Tech.	2,758	1,855	- Diagnostics development - Tokamak and mirror support experiments and theory - Models of plasma behavior - Development of polarized fuels
Univ. of Missouri, Rolla	130	130	- Atomic physics theory and experiment
Univ. of NY State, Buffalo	20	0	- Diagnostics development
New York University	1,010	975	- Plasma theory and algorithm development
North Carolina State Univ.	10	0	- Diagnostics development
Oak Ridge Assoc. Univ.	500	0*	- Manage fellowship program
Pennsylvania State Univ.	57	70	- Diagnostics development - Atomic physics theory - Basic supporting concept physics studies
Rensselaer Polytechnic	300	175	- Diagnostics development
Stevens Inst. of Tech.	15	0	- Atomic physics experiments
Syracuse University	50	0	- Polarized fuel physics
University of Texas	5,182	5,250	- Tokamak user facility and experiments - Fusion theory in support of experiment
University of Washington	620	650	- Beta limits in heliac supporting concept - Long lifetime studies of compact toroids

*The fellowship program will be continued but specific funding has not yet been identified.

Wesleyan University	15	0	- Atomic physics experiments
College of Wm. & Mary	18	18	- Alpha particle theory
University of Wisconsin	1,100	1,780	- Tokamak support experiments - Engineering improvements of stellarators - Stellarator theory - Toroidal theory
Yale University	25	25	- Fokker-Planck codes
Subtotal	18,131	17,418	
Confinement Systems			
Univ. of CA, Berkeley	200	0	- Multiple mirror studies
Univ. of CA, Los Angeles	650	0	- Pump limiter physics
Mass. Inst. of Tech.	17,393	13,000	- Alcator C tokamak - Demonstration of Axicell thermal barrier tandem mirror - ECH potential enhancement - Improve electron heating methods
Univ. of Maryland	76	0	- Temperature diagnostics for TFTR
Univ. of Wisconsin	2,000	1,600	- ICRF ponderomotive effect - RF thermal barrier experiments
Subtotal	20,319	14,600	
Development and Technology			
Auburn University	60	60	- Research in fusion reactor materials development
Univ. of CA, Los Angeles	2,667	2,540	- Research in fusion reactor operations, in the technology of fusion reactor materials, and in nuclear testing facilities for fusion reactor development - Breeder neutronic analysis

Univ. of CA, Santa Barbara	200	150	- Research on fusion reactor materials development
Georgia Inst. of Technology	115	115	- Lead U.S. participation in international program to design of INTOR experiment for fusion research
University of Illinois	300	270	- Research on fusion reactor design and in the technology of fusion reactor fueling
Mass. Inst. of Technology	3,150	2,950	- Research in fusion reactor design and in the technology of fusion reactor superconducting magnets and plasma heating systems
Oak Ridge Assoc. Univ.	673	0[a]	- Manage program of student traineeship for advanced degrees in fusion research
Rensselaer Polytechnic Inst.	100	100	- System design studies
University of Washington	67	0	- Nuclear diagnostic development
University of Wisconsin	1,055	600	- Research in fusion reactor designs and in the technology of fusion reactor materials, superconducting magnets and plasma heating systems
Subtotal	8,387	6,785	
TOTAL	46,837	38,803	

[a]The fellowship program will be continued but specific funding has not yet been identified.

Recent Accomplishments

Auburn University
- Provided electron-impurity ion collisional ionization data
- Initiated study of RF power absorption in Torsatron plasma
- Studied the feasibility of third order harmonic for ICRF heating
- Completed program on development of metal alloys
- Designed fast electron temperature diagnostic for TEXT disruption experiments

California Institute of Technology
- Developed a two fluid model to explain strong coupling between magnetic islands and drift waves in the Cal Tech Encore tokamak
- Initiated studies on a new current drive scheme in tokamaks based on modulation of magnetic fields

University of California, Berkeley
- Applied axially bounded simulation code to plasmas with large potentials to support potential control experiment on TMX-U at LLNL

University of California, Los Angeles
- Initiated operation of new tokamak for testing RF current drive and steady-state heat flow utilizing old magnet coil set from Princeton (ATC coils)
- Used far infrared laser scattering to help understand particle transport on TEXT
- Developed particle simulation techniques to model ICRF in tokamaks
- Analyzed the nonlinear effects of lower hybrid and ion cyclotron frequency heating in tokamaks
- Toroidal cusp ohmic heating experiments conducted at 5 MW power levels that may heat ions to 1000 eV, and experiments continue to measure the ion temperature
- Continuing international study of fusion nuclear testing facilities
- Operated plasma-materials interactions test facility (PISCES) and investigated plasma/materials interactions
- Established physics base for the design of ALT-II pump limiter
- Demonstrated particle control with pump limiters in ALT-1 experiment
- Demonstrated stable operation of a new plasma geometry with two mirror sections coupled by half-toroidal corners
- Initiated a system study of a reversed field pinch power reactor with a team from industry, national laboratories and other universities including people from Japan, Switzerland and the United Kingdom

University of California, San Diego
- Discovered new couplings of external electric field perturbations to plasma instabilities

University of California, Santa Barbara
- Continued studies of fusion reactor material damage by radiation

University of Colorado
- Achieved RFP discharges without conducting shell

Columbia University
- Extended pulse length of high beta tokamak and developed a new concept for second stability (high beta) tokamak
- Simulated the start-up phase of Columbia High Beta Tokamak and followed plasma evolution through field reversal
- Developed variational theory for relaxation of fields and flux conversion in RFP's

University of Connecticut
- Calculated maximum enhancement of electron-ion recombination rates due to electric fields for fusion impurities and fields

Cornell University
- Studied injection of relativistic electron beams for current drive
- Formed and trapped ion rings in magnetic field; tested stronger ion ring source
- Developed stability criteria for large orbit particle rings

Georgia Institute of Technology
- Continued major contributions toward successful U.S. involvement in INTOR

University of Illinois
- Developing fusion reactor design methods and an advanced rail gun concept for fueling

Johns Hopkins University
- Obtained new spectroscopic and atomic physics data from tokamaks and initiated tests of a passive scheme for measurement of magnetic fields inside plasma based on impurity radiation

University of Maryland
- Extended electron cyclotron emission diagnostics using quasi-optical techniques to obtain information on electron energy distribution in mirror end cells
- Discovered that many features of tokamak disruptions can be explained by an $m = 1$ coalescence instability involving the $q = 1$ magnetic island
- Explored the mechanisms for saturation of lower hybrid current drives
- Complete new compact torus device fabrication; initial operations scheduled spring 1986
- Developed coherent theoretical model for tokamak sawteeth which reproduces many experimentally observed features

Massachusetts Institute of Technology
- Discovery of second stability region in tokamaks, development of current drive concept
- Tested different techniques of ICRF heating in high density plasmas, studied LH current drive, and provided data on pellet fueling and impurity control
- Developed the axisymmetric tandem mirror and constructed the TARA device
- Completed design studies of compact ignition tokamak devices
- Discovered detailed shape and stability criterion for long-lived hot electron plasma in quadrupole mirror

Massachusetts Institute of Technology (Continued)
- Developed new diagnostics for studying density and density fluctuations in mirror plasmas
- Extended the maximum plasma density at which RF current drive occurs in small tokamak test
- Provided detailed measurements and interpretation of impurity accumulation after pellet injection modifies plasma properties
- Obtained analytic solution of the 2-D Fokker-Planck equation for lower hybrid current drive
- Performed studies of degradation of electron energy confinement times in the presence of auxiliary heating
- Developed codes to calculate linear axial eigenmodes of ion loss cone instabilities in tandem mirrors
- Developed an analytic theory of clump-like MHD fluid turbulence
- Made key contributions to development of high-field magnets and gyrotrons; successfully tested a 12 Tesla superconducting magnet
- Tested ICRF heating in high density plasmas
- Completed TARA major device fabrication within cost and schedule
- Achieved 15 percent stable beta in a hot electron anchor, a key element in tandem mirror operation
- Reconfiguration of TARA into a thermal barrier tandem mirror by the addition of neutral beams is nearly complete - on cost and schedule

University of Missouri, Rolla
- Initiated experiments on collisions of alpha particles with hydrogen atoms
- Calculated collisional modification of radiation induced by diagnostic neutral beam injection into tokamaks

University of New York State, Buffalo
- Developed laser cavity absorption for diagnostics

New York University
- Developed 3-D codes to model transport in stellarators
- Developed new techniques for modeling rf propagation and heating
- Developed reduced MHD equations for 3-D mirror plasmas
- Developed a model of neoclassical tokamak transport with toroidal flow
- Developed a way of calculating absorption, reflection and mode coupling at the second electron cyclotron resonance in a weakly relativistic, inhomogeneous plasma
- Developed a simple modular winding law for heliacs
- Developed new algorithm for simulating MHD equations which is between 10 and 100 times as efficient as earlier methods

North Carolina State University
- Provided improved detector for measuring energy of fast alpha particles escaping from TFTR

Oak Ridge Associated Universities
- Initiated a program for magnetic fusion science fellowships and managed the fusion technology fellowship program

Pennsylvania State University
- Provided predictive formulas and extensive new theoretical data on electron-impurity ion collisional excitation
- Developed a laser for electron temperature diagnostics
- Analyze impurity influence on RFP discharges

Rensselaer Polytechnic Institute
- Extended heavy ion beam probe diagnostic to higher energies and developed techniques to use this diagnostic for measurements of space potential fluctuations within tokamaks or mirrors
- Initiated operation of beam probe diagnostic on TEXT
- Provided key inputs to system designs for reversed field pinch reactors

Rollins College
- Contributed to improved understanding of electron-ion recombination and ionization rates (under subcontract to Oak Ridge)

Stevens Institute of Technology
- Determined mechanisms controlling production of negative ions in surface-production ion sources

University of Texas
- Operated the Text User Tokamak and improved the diagnostics for temperature and density at TEXT
- Demonstrated that measured electric field turbulence drives particles out of tokamaks at the edge
- Studied enhancement of ion transport by drift waves
- Obtained approximate expressions for anomalous electron transport due to drift waves
- Developed a new variational method for determining 3-D equilibria

University of Washington
- Achieved plasma discharges in revised linear heliac; demonstrated equilibrium and stability with toroidal effects
- Longer duration discharges in new field reversed configuration (FRC) slow source; experiments continue
- Made key contributions to reactor studies conducted at national laboratories
- Initiated development of advanced TLD neutron diagnostics techniques

College of William and Mary
- Calculated the shear Alfven spectrum in a plasma to aid in alpha particle diagnostics in a burning plasma

University of Wisconsin
- Successfully operated tokamaks in the reversed field configuration improving understanding of relationship of tokamak and reversed field pinch plasmas
- Improved diagnostics for studying stellarator and torsatron plasmas
- Included ponderomotive force effects in MHD codes used to model mirror experiments
- Discovered an enhancement of fusion Q by deuterium velocity tails produced by ICRF heating

University of Wisconsin (Continued)
- Discovered that irreversible energy change in second-harmonic ECRF heating of mirror plasmas depends strongly on the energy excursion time and the effective collision frequency that scatters particles out of the resonant region in velocity space
- Completing fabrication of unique, new reversed field pinch
- Made key contributions to materials radiation damage analysis
- Made key contributions for improving the manufacture of superconductors
- Demonstrated that ICRF stabilization can be achieved without significant ion heating, a vital characteristic for use of such stabilization in a reactor
- Completed contribution to a major systems study of tandem mirror reactors
- Developed analytical techniques for analyses of ICRF antenna
- Demonstrated operation of tokamaks with low magnetic field and characterized global energy confinement in new tokamak operation regimes

Yale University
- Developed kinetic theory of Alfven wave heating
- Applied the Yale geometric optics code to the change in the propagation of RF near the cyclotron frequency due to the newly discovered corrections to the dielectric tensor

Mr. Bevill. Given the President's endorsement of magnetic fusion at the Geneva Summit, why did the Administration propose cutting the budget in FY 1987?

Dr. Trivelpiece. The cuts that you refer to in the FY 1987 budget were made in selective areas, such as research on the tandem mirror concepts. Our ability to cooperate with the Soviets will depend on events that are still developing and it is too soon to determine whether or not the present budget reduction will have any direct effect. However, it is a matter of concern in the sense that we may not be taken seriously if we are reducing the program at the same time that we are proposing expanded collaboration.

MFTF-B

Mr. Bevill. We understand the Mirror Fusion Test Facility was recently completed and underwent initial testing successfully. Is that correct?

Dr. Trivelpiece. Lawrence Livermore National Laboratory recently did complete a successful test of the MFTF-B facility. All 24 superconducting magnets were tested, under vacuum, at full magnetic fields simultaneously. During the test, the world's largest liquid helium system maintained the magnets at minus 452 degrees Fahrenheit. The magnets were in a 190 foot, almost 3,000,000 pound tank which was vacuum tight. While the magnets were on, two intense particle beams and a single high power microwave tube were tested in the tank. All these tests were carried out using state-of-the-art computer controls and were all completed successfully.

Mr. Bevill. How much has been spent on the MFTF-B to date?

Dr. Trivelpiece. A total of about $354 million will have been spent through FY 1986 including $241 million for construction and $113 million for

design, research and development support, and fabrication of experimental equipment.

Mr. Bevill. Given the investment already made in MFTF-B, why is the Administration proposing mothballing it?

Dr. Trivelpiece. As you know, the Gramm-Rudman-Hollings Law requires austere budget goals for government expenditures. The Department of Energy had to accommodate these budget pressures. This has resulted in a reduced Magnetic Fusion Energy Program budget. In order to accommodate these reductions, difficult decisions on what could be afforded had to be made. We decided to maintain the scientific strength of the program needed for international collaboration on the tokamak, while also maintaining an advanced toroidal program to build and improve upon the tokamak concept.

Mr. Bevill. Is there international interest in the MFTF-B?

Dr. Trivelpiece. We have held preliminary, informal discussions with the Japanese on MFTF-B collaboration. They have shown some interest, but like us, have to first balance their program priorities and then identify funds. No funds are seen as immediately available from these discussions.

Mr. Bevill. Is it realistic to suppose that international support for MFTF-B will be forthcoming if the US drops Mirror Research altogether?

Dr. Trivelpiece. We cannot determine whether there will be international support until we have further explored this subject with foreign interests.

Mr. Bevill. What additional support would be required to continue mirror research at some level?

Dr. Trivelpiece. It would take roughly $10M/year to maintain a university research program in this area.

BURN EXPERIMENT

Mr. Bevill. The new DOE magnetic fusion program plan contains a schematic diagram which could be read to indicate the start decision for the Burn Experiment, Blanket Test Facilities, and Materials Test Facilities will be made before the early 1990's. If DOE is still having problems with alpha particle burning experiments, why would DOE be deploying these other facilities?

Dr. Trivelpiece. These are major facilities needed to develop the science and technology base for fusion. We expect to have information from TFTR and D-III as well as JET and JT-60 within the next two years that will enable us to design an experiment to study the science of burning plasma. The other facilities you mentioned are needed in parallel. We do not, however, plan for DOE to deploy all of these facilities on its own. We have been engaged in discussions with our allies under the auspices of the Economic Summit on this very subject for over two years now. With the President's initiative at Geneva, the Soviets may also be brought into the effort to combine resources for fusion development.

Mr. Bevill. What is meant by the post-2000 "Fusion, Economic and Environment assessment"?

Dr. Trivelpiece. The post-2000 "Fusion, Economic and Environment Assessment" is to be an assessment of possible applications of fusion

energy, an assessment that would precede decisions to begin commercial development of fusion. It will be an assessment comparing the economic and environmental factors of fusion to other energy sources.

MAGNETIC FUSION PROGRAM PLAN

Mr. Bevill. Provide for the record the current magnetic fusion program plan.

Dr. Trivelpiece. The magnetic fusion program plan is provided for the record.

(The information follows:)

DOE/ER-0214

Magnetic Fusion Program Plan

February 1985

U.S. Department of Energy
Office of Energy Research
Washington, D.C. 20585

58-755 O - 86 - 21

U.S. DEPARTMENT OF ENERGY

Office of Energy Research

February 1985

The fusion program strategy takes into account the key science and technology issues, available resources, and the nation's need for future energy sources.

PREFACE

During the past few years, there have been some substantial changes in the energy and economic circumstances in the United States and elsewhere. This has resulted in the need to make some changes in the priorities of certain programs within the Department.

During the early period (1973-1976) of National concern over the then looming energy crisis, the Magnetic Fusion Energy Program laid out a plan that was dedicated to the goal of a working fusion energy reactor system by the year 2000. This goal and the Plan based on it were used to guide the Program's activities and to determine the support levels until the past few years. Although the need for and desirability of an energy supply system based on the nuclear fusion principle have not diminished, there is less urgency to develop such a system by the year 2000.

The United States and several other Nations have made substantial investments in the equipment and in the training of scientists and engineers needed to make progress in this complex field of research. Although some of the problems have proven to be more difficult to solve than originally anticipated, excellent and sustained progress has been made in solving them. It is generally agreed that the remaining problems can be solved and that practical fusion reactor systems can be developed.

What is needed now is a revised Magnetic Fusion Program Plan that takes into account the present economic conditions, the energy situation now and in the future, the role of technical progress in fusion research, the role of the Program in training scientists and engineers, the contributions to basic research in the fields of plasma physics and atomic physics, and technology transfer.

This Plan reflects the present conditions of the energy situation and is consistent with National priorities for the support of basic and applied research. It is realistic in taking advantage of the technical position that the United States has already established in fusion research to make cost-effective progress toward the development of fusion power as a future energy option.

Alvin W. Trivelpiece
Director, Office of
Energy Research

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MAGNETIC FUSION PROGRAM PLAN

EXECUTIVE SUMMARY

Goal

The goal of the National Energy Policy Plan is to foster an adequate supply of energy at reasonable costs. As an element in this Plan, the goal of the magnetic fusion program is to establish the scientific and technological base required for fusion energy.

Technical Issues

Although magnetic fusion research and development is addressing a wide spectrum of detailed scientific and technological problems, the remaining work to reach the program goal can be summarized by four key issues. These are magnetic confinement systems, properties of burning plasmas, materials for fusion systems and nuclear technology of fusion systems.

Objectives

Given the nature of the key technical issues, three strategic objectives in the areas of science, technology and technology transfer are necessary to reach the program goal. The science objective is to be able to predict, control and optimize the behavior of plasma confined in fusion relevant magnetic configurations. The technology objective is to show that it is possible to create the unique fusion components and subsystems under conditions relevant to fusion energy sources. The technology transfer objective is to provide a range of options for private sector investment and commercial development of fusion.

Schedule

The schedule for completing magnetic fusion development is directly related to the technical, economic and political uncertainties associated with the energy supply, which are likely to exist for several decades. The Magnetic Fusion Program Plan is a strategy for solving fusion's technical problems within a time frame keyed to resolution of problems in other areas of energy development.

Assuming that the strategic objectives for fusion research and development are achieved, a sufficient scientific and technological base will exist to assess the technical and economic potential of fusion as an energy resource.

Strategy

The strategy adopted to reach the program goal must take into account the key technical issues of fusion, the schedule for program completion and the available resources.

The essence of the program strategy is to maintain a broad domestic research and development program with emphasis on establishing the basic elements (components or subsystems) of the science and engineering technology required for fusion. The focus on the practical energy goal of the program will be provided by fusion system studies. Technology transfer will be pursued by seeking industrial and utility participation in these system studies, as well as in appropriate research and development.

Resources

The resources necessary to pursue a successful fusion program consist of technical personnel, annual budgets and international collaboration.

Technical Personnel. Skilled technical personnel are a major element of the program's resources. In spite of strong competition for fusion trained graduates by defense and industrial activities, the program expects to continue to attract the high quality professionals needed over the coming decade. This will be accomplished by continuing to support a central research activity in the universities and maintaining a vital, creative research element within the overall program.

Budgets. The estimate for budget needs is based on two major factors. The first is the need to maintain a balance between our domestic science and technology program and those abroad to allow for effective international collaboration. The second is the need to support appropriate experimental investigations. Facilities that are large enough to explore high temperature regimes of plasma physics are required, as well as smaller facilities for investigating key technological problems or scientific issues at more modest plasma temperatures.

International Collaboration. The United States purpose in collaborating internationally is to establish an adequate fusion science and technology base in a timely fashion.

During the next five years, a concentrated effort will be

made to identify cost-effective component and system test facilities for resolving the key technical issues. A key element in this effort will be the attempt to establish an international consensus on the nature of these facilities. If the result is that more integrated and expensive facilities are needed than can be accommodated by the budgets of individual national fusion programs, then the degree of international collaboration achieved will dominate the schedule for achievement of our goal.

Technical Milestones and Decisions

The major technical milestones and necessary decisions for achieving the program goal and objectives are summarized in the Plan. The subprogram elements are highly interrelated and are all necessary for an assessment of the potential technical, economic and environmental merits of fusion. The milestones should be interpreted as goals that can be achieved with steady domestic support and significant international cooperation and collaboration. They form the framework for detailed annual program planning and for international negotiations.

Upon completion of the milestones, sufficient information will be available to achieve the program goal and objectives. At that point, it would be possible to proceed with the design of an integrated magnetic fusion system based upon the results of all of the scientific and technological test programs of the 1990's. On this basis, it should be possible to proceed into the subsequent stages of process development and commercialization.

I

MAGNETIC FUSION'S ROLE IN NATIONAL ENERGY POLICY

The goal of the National Energy Policy Plan is to foster an adequate supply of energy at reasonable costs. The principal strategy adopted to achieve this goal is to promote a balanced and mixed energy resource system with minimum federal control and involvement. One appropriate federal function is sponsorship of research and development programs for alternate energy sources where cost or duration of the program prohibits private investment. The magnetic fusion program is one of the clearest examples of appropriate energy research in the federal research and development portfolio.

The schedule for completion of magnetic fusion development is directly related to the technical, economic and political uncertainties of energy supply, which are likely to exist for several decades.

With appropriate support, the magnetic fusion program can provide the scientific and technological base for a major new energy option. The Magnetic Fusion Program Plan is a strategy for solving fusion's technical problems within a time frame keyed to resolution of problems in other areas of energy development. The Plan discusses the program goal, key technical issues, objectives, schedule and strategy, required resources and major technical milestones.

This Plan is the strategic framework within which implementation plans to achieve the program goal will be formulated. The implementation plans will be updated on a continuing basis, taking into account funding, scientific and technological progress, and future international agreements to collaborate on specific technical tasks.

II

PROGRAM GOAL AND MOTIVATION

The goal of the magnetic fusion program is to establish the scientific and technological base required for fusion energy. Achievement of this goal, along with a successful technology transfer effort, will enable decisions on whether fusion deserves further development as part of the national response to the energy realities of the next century.

The development of magnetic fusion could lead to economic energy sources that possess a secure fuel reserve as well as attractive environmental and safety features. The fuel, deuterium, is readily available at low cost, and the supply is essentially unlimited. Potential end use applications are electricity generation and production of synthetic fuels, nuclear fuels and high grade heat for industrial applications.

Nearer term benefits of fusion development include an increase in the understanding of plasma physics and related scientific fields, as well as the attraction and training of outstanding scientists and engineers. Fusion related science combines plasma physics, atomic physics, nuclear physics, surface and solid state physics, and advanced computational techniques. Fusion related technology involves superconducting systems, large magnetic systems, high power radio frequency heating systems, tritium processing, high heat flux energy recovery systems, advanced materials development, nuclear technology, real-time computer control, novel scientific instrumentation, unique vacuum systems and particle beam heating systems. The technology developed in support of fusion research has many applications in science, industry and defense.

Magnetic fusion research also has an important international dimension. The fusion programs of the world have a history of successful cooperation and collaboration. Scientific and technological progress within the fusion field has benefited greatly as a result. Recently, the Versailles Summit Working Group on Technology, Growth and Employment recognized that international collaboration in science and technology, specifically including fusion, can play an important role in improving general economic growth and employment and in stimulating culture and education.

III

KEY TECHNICAL ISSUES FOR MAGNETIC FUSION

Although magnetic fusion research and development is addressing a wide spectrum of detailed scientific and technological problems, the remaining work that must be accomplished to reach the program goal can be summarized by four key issues.

The first of these issues is magnetic confinement systems. Development of a variety of magnetic confinement systems is essential to achieving the program's goal. Although significant technical progress continues to be made, at this time it is not possible to design a fusion reactor. It is quite possible that further development of the tokamak concept will lead to an economic fusion system. However, it is likely that the most desirable fusion reactor systems, in the next century, will require features from other types of magnetic confinement systems. Furthermore, the history of fusion development has shown that progress in all systems will be more rapid because of the cross fertilization possible between related concepts. Therefore, it is essential to explore an appropriate range of possibilities for magnetic confinement.

The second key technical issue is properties of burning plasmas. Achievement of the program goal requires that at least one burning plasma be produced and studied to complete the scientific base. Furthermore, since a burning plasma will require much of the technology required for a fusion reactor, such an experiment offers the additional benefit of advancing the technological portion of the goal.

The third key technical issue is materials for fusion systems. Since materials play a central role in determining the environmental characteristics of a fusion reactor, they are the key to realizing the benefits of fusion. Achievement of the program goal requires the development of new materials with properties that enhance the economic and environmental potential of fusion.

The fourth key issue is nuclear technology of fusion systems. While the three key technical issues mentioned above blend the fruitful basic and applied research that have characterized the fusion program to date, this last issue requires advances in the basic engineering sciences, as well as the application of the results of basic fusion materials research. Fusion blankets have a generic function in all fusion systems. However, to achieve the program goal, a certain breadth of technology must be maintained in order to be able to optimize the economic, safety and environmental performance of fusion reactors. This research program will be completed only when integrated blankets are tested in a nuclear environment.

A more detailed description of the four key issues for magnetic fusion is provided on the following page.

KEY TECHNICAL ISSUES FOR MAGNETIC FUSION

Magnetic Confinement Systems

A variety of magnetic fields can be used to confine and insulate a fusion plasma. However, the confined plasma interacts with different confining magnetic fields in ways that affect the heating and confinement efficiency of the system. The unique nature of this interaction creates the scientific richness of fusion plasma physics. The nature of the fusion reactor will also be profoundly affected by the particular magnetic configuration. The size of the reactor, the ease of operation, and the cost of construction all depend on understanding the scientific principles of the interactions of the fusion plasma with the magnetic confinement configuration.

There are only two basic magnetic structures which have been shown to confine plasmas of fusion interest: the magnetic mirror and the magnetic torus. However, each of these magnetic confinement systems has several variations. These confinement systems differ in practice by emphasizing particular principles of fusion science to improve plasma confinement or to simplify the technical requirements for producing the magnetic fields. Historically, the tokamak, a toroidal confinement concept, embodied a set of principles which was comparatively easy to implement in the laboratory. As a result, most of the scientific progress has been made with this concept. Today tokamaks are unique in the ability to produce the most fusion reactor-like plasmas for scientific study.

The rapid scientific and technological development of the fusion program in the last decade, resulting in large part from successful tokamak experiments, has contributed to overcoming many of the technical difficulties of other magnetic confinement concepts. We are fortunate to have a number of concepts which are now beginning to catch up with the tokamak. In addition, the tokamak concept itself has begun to evolve rapidly because of discoveries in tokamak research and ideas generated by research in these other concepts.

Properties of Burning Plasmas

Resolution of the confinement issue depends on a fundamental scientific understanding of several magnetic confinement principles. All of these principles are now under investigation, with the exception of those associated with a burning plasma. The new physical phenomena in the burning state will also require study. A fusion plasma is said to burn when the heat released within the plasma by the fusion reaction is sufficient to maintain the plasma temperature in face of heat loss from the system. In order to attain this state, one must solve scientific problems of magnetic confinement which are prerequisites to achieving the necessary insulation. Only the tokamak confinement system is approaching the point at which this condition might be achieved. Identification of the conditions required for ignition is expected to occur in the United States experiment, Tokamak Fusion Test Reactor, within two years. Initial experiments with significant fusion reactions are planned for following years. At the same time, studies are proceeding to specify a cost-effective experiment to investigate the physics of burning plasmas.

Fusion Materials

The ultimate economics of fusion energy, like most other energy systems, will depend on the materials required for the system. Fusion materials research separates naturally into two classes of problems: those associated with interaction of plasma with the materials and those associated with the interaction of fusion neutrons with the materials. Both involve basic and applied research. However, the former are near-term problems which must be solved to advance plasma confinement research. The latter problems are more fundamental to the ultimate success of fusion as an energy source.

The last decade of research, using available nuclear test facilities, has revealed that there are materials which could withstand the nuclear environment of a fusion reactor with reasonable system economics and relatively modest waste disposal requirements. However, studies have also shown that it is important to improve the economics of these systems and to reduce the need for long-term waste disposal of fusion materials even further through the development of specialized materials. The future fusion materials program must include both the basic research on fundamental new materials and the development of the new technology required for testing those materials.

Fusion Nuclear Technology

In a fusion reactor, most of the energy is recovered from a structure surrounding the fusion plasma. This structure is known as a fusion blanket and must perform several functions besides converting the energy released by the fusion plasma into useful heat. The blanket must also use the energetic neutrons emitted from the plasma to create part of the fuel for the fusion reactor and allow recovery of this fuel. It is even possible that the blanket might be used to produce nuclear fuel for use in fission reactors. The blanket also shields the outside world from radiation, but in doing so becomes radioactive. It is clear that as the major radioactive component of a fusion system, the blanket is the main focus of interest for safety and environmental concerns.

There are several technical options, based on combinations of different materials and technologies, to perform the various blanket functions. Moreover, different confinement concepts may impose different limitations on these technologies and on overall blanket design. These individual technologies can be evaluated on their ability to satisfy the blanket function in the most acceptable way. However, each of the blanket functions is so interrelated in practice that an integrated research and development approach is required.

IV

PROGRAM OBJECTIVES

Given the nature of the key technical issues, there are three strategic objectives in the areas of science, technology and technology transfer, which must be achieved in order to reach the program goal.

Science Objective

The science objective is to be able to predict the behavior of plasma confined in fusion relevant magnetic configurations. There are several magnetic confinement systems that could develop into reactors. Each has special features that could make the difference between an acceptable and a non-acceptable reactor. Furthermore, new variations and improvements will likely emerge as our understanding of plasma physics matures. Since budget constraints preclude parallel development of all possible ideas to the same level of performance, a predictive scientific understanding is essential to make an informed choice of the best direction for fusion development.

Technology Objective

The technology objective is to develop unique fusion components that can operate under conditions relevant to fusion energy sources. Practical fusion power will depend on a host of technological components. Many of these are within the purview of industry. There are, however, certain technological components of fusion systems which are unique, either because they are beyond the industrial state-of-the-art or because of new requirements imposed by the special conditions of a fusion system. Such unique components exist in the areas of magnetics, plasma heating, energy removal, fuel production and materials. These components must be developed and tested by the program to be able to forecast the economic and environmental characteristics of fusion reactors.

Technology Transfer Objective

The technology transfer objective is to provide a range of options for private sector investment and commercial development of fusion. The establishment of the scientific and technological base for fusion requires industrial participants both to provide expertise in conventional components and to gain experience with the unique aspects of fusion science and technology. The necessary degree of industrial experience is best gained through the technical participation of industrial personnel in the state-of-the-art developments produced by the fusion program. A noteworthy aspect of this objective is that through it, the fusion program will also serve as a stimulus to United States technological growth and the further training of scientists and engineers in industry.

V

PROGRAM SCHEDULE AND STRATEGY

Program Schedule

The schedule for completion of the fusion program objectives is determined by one of the key aspects of the National Energy Policy Plan strategy; namely, to promote a balanced and mixed energy resource system. At the present time, there is a great deal of uncertainty in the United States energy future associated with the present mix of energy resources. This uncertainty will persist for some time because of political and economic influences on international and domestic fuel supply, as well as the long time needed for assessments of the environmental impacts of current energy sources.

Assuming that the strategic objectives for fusion research and development are achieved during the 1990's, a sufficient scientific and technological base will exist to assess the technical and economic potential of fusion as an energy resource. This information, coupled with knowledge of factors that affect the economic future of fossil, nuclear and alternate energy sources other than fusion, will provide a basis for decisions on future directions for fusion development.

The essential aim of the magnetic fusion program is to develop the scientific and technical information needed to reach the point where fusion can be considered as an option in the future mix of energy resources available in the United States.

Program Strategy

In the past the centerpiece of United States fusion program planning has been envisioned as an integrated fusion test facility which served to develop fusion science and, simultaneously, to test both the plasma-related and the nuclear-related technologies required for fusion. This was considered to be a cost-effective route to achieving the program goal especially when national need gave a sense of urgency to the deployment of new energy technology. However, because of improvements in the present energy situation, this approach should be revised.

Although the fusion program must plan for decade-long efforts to resolve key scientific and technological problems, it operates on year-to-year appropriations. A key feature of a durable program strategy is, therefore, its ability to accommodate deviations from planned annual budgets. When construction of centerpiece projects dominates program expenditures, budget perturbations are particularly difficult to accommodate without endangering essential program balance. Our present strategy, therefore, is to take a complementary approach which emphasizes development of the scientific and technological components or subsystems of the integrated fusion system, to the maximum extent that is technically feasible.

This approach is most appropriate for our program goal, as well as for the technical uncertainties which exist about the exact nature of a suitable fusion reactor. In addition, there appears to be no premium on early deployment of fusion in our present energy circumstances, and time is available to perfect the necessary fusion energy source. Finally, the utilization of the United States portion of the world's fusion development resources can be enhanced by this approach since it provides the flexibility to collaborate internationally.

The essence of the program strategy is to maintain a broad domestic research and development program with emphasis on establishing the basic elements (components or subsystems) of the science and engineering technology required for fusion. The focus on the practical energy goal of the program will be provided by fusion system studies. Technology transfer will be pursued by seeking industrial and utility participation in these system studies, as well as in appropriate research and development activities.

To make best use of United States scientific strength in the area of fusion plasma research, a number of magnetic confinement systems, which offer promise of superior reactor performance, will be investigated. However, recognizing constraints on available resources, this investigation will emphasize increasing scientific understanding of the unique features of the most promising concepts, rather than attempting to develop each as a separate reactor system. To achieve a complete scientific base, we will address the scientific issues of fusion in depth through the generation and study of high temperature plasmas in facilities of appropriate size and scope, including a burning plasma experiment. In the latter experiment, the lowest cost magnetic confinement system which can meet the scientific objective will be sought. This approach is intended to provide the broadest understanding at minimum cost and is most appropriate for the present stage of fusion development.

A similar approach will be used to achieve our technology objective. Plasma-related technologies will be developed as appropriate to support the advance of the experimental program. Since this program must include a burning plasma facility, this should ensure sufficient development of most plasma-related and some nuclear-related technologies that are necessary to achieve the program goal. The remaining technological components will be developed with specialized test facilities. A considerable effort will be devoted to the development of cost-effective facilities in the materials and nuclear technology areas.

Finally, in the area of technology transfer, in addition to seeking industrial and utility involvement in systems studies, we will concentrate on maximizing the interaction of laboratory, university and private sector technical personnel within the fusion program. This will be done through appropriate R&D contracts, personnel exchanges and joint programs.

VI

RESOURCES

The resources necessary to pursue a successful fusion program consist of technical personnel, annual budgets and international collaboration. The difficulty and timescale of fusion development are such that significant quantities of each will be required.

Technical Personnel

Skilled technical personnel are a major element of the program's resources. For more than thirty years, the magnetic fusion program has attracted some of the best scientific and engineering talent throughout the United States. Over that period of time, the scientific discipline of plasma physics has matured into one of the largest and most active fields of science in the United States. In addition, the program has fostered the development of a valuable group of interdisciplinary engineering scientists who can combine standard engineering disciplines with the systems integration of the many different technologies required for fusion.

American universities have played a key role in educating the generation of talent responsible for the success of the magnetic fusion program in the last decade. These universities have accomplished this through their central involvement in the most challenging research and development problems of the fusion program. This involvement has attracted the high quality of personnel required for this difficult field and helped maintain quality engineering graduate programs. In spite of strong competition for fusion trained graduates by defense and industrial activities, the program expects to continue to attract the high quality professionals needed over the coming decades. This will be accomplished by continuing to support a central research activity in the universities and maintaining a vital, creative research element within the overall program.

Annual Budget

The estimated budget level is based on two major factors. The first is the need to maintain a balance between our domestic science and technology program and those abroad in order to allow effective international collaboration. The second is the need to support appropriate experimental investigations. Facilities that are large enough to explore high temperature regimes of plasma physics are required, as well as a number of smaller facilities for investigating key problems or scientific issues which can be addressed at more modest plasma temperatures.

The funding required through the 1990's will be determined by the facilities and program schedule needed to reach the program objectives in a timely fashion. The determination of the magnitude and complexity of the facilities will be based on technical results of the program over the next five years. However, the schedule will depend on scientific progress, the perceived need for the program to pursue its goal at the specified rate, and the extent of international collaboration.

During the next five years, a concentrated effort will be made to identify cost-effective component and system test facilities to resolve the key technical issues by the turn of the century. A key element in this effort will be the attempt to establish an international consensus on the nature of these facilities. If the result is that more integrated and more expensive facilities are required than can be accommodated by the budgets of the individual national fusion programs, the degree of international collaboration achieved will dominate the schedule for achievement of our goal.

International Collaboration

The purpose of the United States in cooperating internationally is to advance the prospects for establishing a sufficient fusion science and technology base in a timely fashion. The magnetic fusion programs of the world currently have a vigorous program of international cooperation and collaboration that includes scientific and technological exchanges, joint experiments and joint planning activities. These activities will be strengthened to emphasize international involvement, at an early stage, in planning for major new activities and facilities. This should enable us to identify mutually advantageous opportunities for collaboration and, on a case by case basis, to negotiate agreements which will minimize duplication and accelerate the achievement of our common goals.

VII

MAJOR TECHNICAL MILESTONES AND DECISIONS

The major technical milestones and decisions for achieving the program goal and objectives are identified below and summarized in the following Figure. As shown in the Figure, the program elements are highly interrelated and lead to an assessment of the potential technical, economic and environmental merits of fusion. The milestones should be interpreted as goals that can be achieved with steady domestic support and appropriate international cooperation and collaboration. They form the framework for detailed annual program planning and for international negotiations.

Milestones for around the year 1990 follow.

1. Establish a sufficient theoretical and experimental understanding of magnetic confinement of a hydrogen plasma to begin experiments to establish the characteristics required for a fusion reactor.
2. Establish a sufficient theoretical and experimental understanding of tokamak plasma behavior to allow a cost-effective burning plasma experiment.
3. Establish the nonnuclear fusion technology required for all of the above experiments.
4. Complete small-scale screening tests and analytical studies of candidate blanket features and plan a generic blanket test program, including an appropriate blanket test facility.
5. Complete fusion materials screening studies and evaluations necessary to proceed with a materials testing program in an appropriate neutron source that is capable of testing materials on an accelerated basis.

The above five milestones are based upon full utilization of existing fusion facilities for about the next five years and provide the basis for the following decisions around the year 1990. At the time the decisions are made, full consideration will be given to accomplishing more than one activity in one facility in order to reduce costs.

1. For the most promising confinement concepts, proceed with hydrogen experiments with plasma characteristics close to the reactor level.
2. Proceed with an ignited, long-pulse, burning plasma experiment.
3. Proceed with a generic blanket test program, including an appropriate nuclear source facility.
4. Proceed with a materials test program, including an appropriate neutron source facility.

Assuming that decisions are made to proceed as indicated above either within the United States fusion program, within a foreign program or through international collaboration, the following milestones are established for around the year 2000.

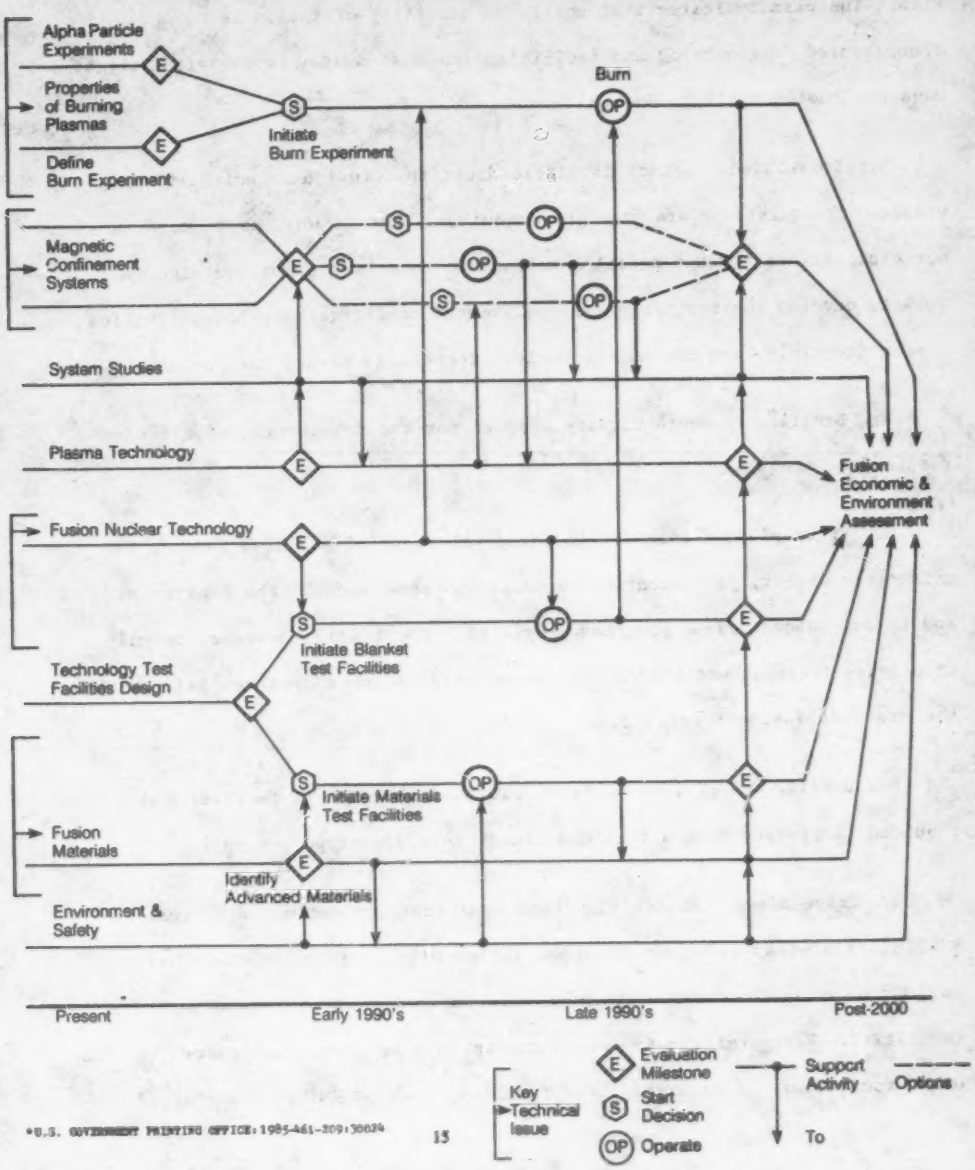
1. Define optimized magnetic confinement configurations based upon results from the burning plasma experiment and the promising confinement concepts coupled with improved theoretical understanding of plasma behavior.
2. Confirm the adequacy of the nonnuclear fusion technologies.
3. Define a blanket configuration that would be compatible with the optimized magnet configuration defined in item 1 above based upon results from the generic blanket test program.
4. Establish the acceptability of materials that could be used in the optimized magnet confinement configuration and blanket defined in items 1 and 3 above based upon end-of-life materials testing information.
5. Establish sufficient industrial participation to allow effective private sector synthesis of program results.

In addition, environmental and safety activities will be required on a continuing basis in support of all the above milestones. Finally, throughout this period, systems studies will be required in order to guide the above decisions and to identify economical and environmentally acceptable directions for an integrated magnetic fusion system.

Upon completion of the above milestones, sufficient information will be available to achieve the program goal and objectives. At that point, it would be possible to proceed with the design of an integrated magnetic fusion system based upon the results of all of the scientific and technological test programs of the 1990's. In addition, it should be possible to proceed into the subsequent stages of process development and commercialization.

THE FOLLOWING FIGURE ILLUSTRATES THE MILESTONES AND DECISIONS OF A PLAN TO REACH THE FUSION PROGRAM GOAL. THE SUBPROGRAMS ARE INTERRELATED AS SHOWN. THIS INTERRELATIONSHIP WILL BE PRESERVED ALTHOUGH THE SPECIFIC FACILITIES AND TIMING SHOWN WILL VARY TO ACCOMMODATE TECHNICAL RESULTS, ANNUAL BUDGETS, AND THE DEGREE OF INTERNATIONAL COLLABORATION ACHIEVED.

Magnetic Fusion Program Plan
Major Technical Milestones and Decisions



*U.S. GOVERNMENT PRINTING OFFICE: 1985-461-209:30624

Mr. Bevill. Congressional options for the fusion program should be understood in the context of the new (February 1985) Magnetic Fusion Program Plan. The plan indicates that until the viability of fusion is demonstrated, engineering and facilitization must wait. Is the viability of magnetic fusion still in doubt?

Dr. Trivelpiece. There is little doubt that fusion is scientifically viable. The questions are ones of economics. That is why, as we confirm our expectations through detailed scientific experimentation, we also must work to develop the best magnetic confinement configuration, low-activation fusion materials, and the unique nuclear technology needed for fusion.

Mr. Bevill. Is there utility support for the development of a fusion reactor?

Dr. Trivelpiece. Interest in the development of a fusion reactor is evident in utility participation on advisory committees to the Department and to our laboratories' programs. Utility support will, however, be only of passive interest until such time as we achieve the milestones laid out in the Magnetic Fusion Program Plan.

Mr. Bevill. In FY 1985 dollars, estimate the cost of facilities required to proceed from a burn experiment to a prototype reactor?

Dr. Trivelpiece. An ignition/burn experiment is estimated to cost $300 million at an existing developed fusion site. Design studies that would produce quality cost estimates have not been done for the other facilities. Very preliminary estimates can only be approximated for the other facilities. A materials test facility, such as FMIT, is estimated at

$250 million. An Engineering Test Reactor for nuclear technology is estimated at $3 billion. A few $100 million experiments may be needed for other magnetic confinement concept development, but I expect we may be able to use existing scientific facilities for some of these.

Mr. Bevill. What is the earliest projected year a fusion reactor would be needed?

Dr. Trivelpiece. Because of the many unknown factors external to the program, it is difficult to accurately predict when a fusion reactor will specifically be needed. Considering the technical uncertainties associated with other energy sources, it is not unreasonable to assume that fusion will be needed by the early to mid twenty-first century. This is consistent with our goal of establishing the science and technology base by the turn of the century.

Mr. Bevill. If fusion reactors are developed, will the United States need advanced nuclear reactors?

Dr. Trivelpiece. Assuming we are successful in developing both advanced nuclear reactors and fusion reactors, any decision to develop and deploy either would depend upon an assessment of the relative economic and environmental characteristics of the two.

ENVIRONMENTAL COMPLIANCE AND SAFETY RECORD

Mr. Bevill. How would you characterize the Department's current environmental compliance and safety record?

Ms. Walker. The Department's safety and health record is excellent. Without exception, for each year since its creation, the Department has carried out its operational missions with a safety and health record that is at least two-to-three times better with respect to fatalities, injuries, and illinesses, and more than ten times better with respect to property protection, than that of the private sector.

The record of DOE's environmental compliance is a mixed one. The agency has been operating in an increasingly complex and dynamic situation regarding environmental laws and regulations. Moreover, like many large industrial concerns we have been severely challenged to meet the plethora of diverse and changing requirements we have had to deal with. Some of our facilities have been in use for nearly 40 years and many of the environmental problems we are finding at DOE facilities represent a "legacy of the past," from activities conducted in a different atmosphere and under different standards than are applied for today's more sophisticated and highly publicized environmental and safety criteria. What was acceptable in 1945 is not acceptable in 1986. This has required DOE to reevaluate its environmental programs, and I hope to see this record improve.

Mr. Bevill. What have been the deficiencies of the past that have created the current situation?

Ms. Walker. DOE has operated traditionally on a decentralized basis through operations offices; moreover, it has operated its facilities through

GOCO's. Limited headquarter's review under this method was satisfactory in a period when environmental knowledge and regulatory requirements were limited. The current state of affairs in terms of environmental awareness and the regulatory structure is such that continuation of this approach is not satisfactory. Secretary Herrington has responded by reorganizing the DOE to create a beparate and centralized ES&H organization within headquarters. That organization will ensure adequate guidance and oversight of field operations in the future.

Mr. Bevill. Describe the Secretary's initiative to improve the Department's environment and safety record.

Ms. Walker. First, oversight responsibility for the environment, safety and health function in the Department has been consolidated and upgraded under the new Assistant Secretary for Environment, Safety and Health. ES&H is now integrally involved in the operation of the Department at all levels, is directly overseeing the environmental and safety aspects of the Department's ongoing operations and necessary corrective actions, and is more integrally involved in decisions affecting those operations.

Second, ES&H will conduct a baseline Environmental Survey of all DOE facilities to identify Department-wide existing environmental problems and areas of potential risk and to prioritize corrective action. The onsite Survey activities scheduled to begin in FY 1986 will take about 2 1/2 years to complete and will enable the Department to develop long-range planning for correcting environmental problems and reducing potential risks.

Third, ES&H will conduct Technical Safety Appraisals of DOE's nuclear facilities to determine compliance with safety requirements, industry lessons

learned, and licensed facility requirements. These will be on-site technical appraisals of all aspects of safety, including nuclear reactor safety, nuclear process facility safety, health physics, training, emergency preparedness, occupational medicine, occupational safety, fire protection safety, and transportation and packaging safety. The Technical Safety Appraisals, begun in February 1986, will be completed in about 3 years.

Mr. Bevill. What is being done in FY 1986 to implement the Secretary's initiative?

Ms. Walker. During FY 1986, we will begin implementation of both the Environmental Survey and the Technical Safety Appraisals. All necessary planning and preparatory activities will be completed for the Survey and the first group of sites will be surveyed beginning in June at the Feed Materials Production Center, Fernald, Ohio. The Technical Safety Appraisals, which began in February 1986, will proceed to additional facilities.

In addition, we have begun work on the Computer Assisted Tracking System, a key initiative that will assist in monitoring compliance and progress in the completion of corrective actions and in reducing areas of environmental and safety risks. The DOE Safety and Quality Assurance Orders are being revised, and the DOE Environmental Orders will be reviewed and revised as appropriate. We are providing environmental guidance and compliance assistance to the field, and are coordinating Departmental environmental activities such as compliance with RCRA and CERCLA.

FY 1987 ENVIRONMENTAL AUDIT AND COMPLIANCE

Mr. Bevill. What specifically will be done with the $26 million increase for "Environmental Audit and Compliance" activities?

Ms. Walker. The FY 1987 request for the Office of Environmental Audit and Compliance is $34 million, which is a $26 million increase over the adjusted FY 1986 level. $30 million would be used for the Environmental Survey activities at 20 DOE sites, including the onsite survey, sampling and laboratory analysis. The remaining $4 million would fund a range of continuing support and oversight functions, including technical support and assistance in resolving problems associated with environmental permitting, technical reviews of environmental control and remedial action projects, coordination of the resolution of Departmental-wide environmental compliance issues, and preparations of statutorily mandated Departmental reports such as the Federal Facilities Inventory Report required under Section 3016 of RCRA.

Mr. Bevill. What will be done at the individual DOE sites with these audits and what will the product be?

Ms. Walker. The purpose of the Environmental Survey is to identify Department-wide existing environmental problems and areas of potential risk and to prioritize corrective action.

The Environmental Survey covers all media (air, water and soil) and all areas of environmental regulation. The Survey also covers all DOE programs and major operating facilities: about 40 DOE sites at which there are an

estimated 600 inactive waste areas, 300 hazardous waste management areas, 1800 air emission stacks, and 400 water discharge pipes.

The Survey will include observations of operations, collection and review of records and documents, personnel interviews and a study of the site's overall environmental status and sampling. Sampling and related testing and analysis will be conducted by DOE labs in accordance with appropriate methods and procedures and the individual sampling plans developed by the survey teams.

The Survey is a long range planning and internal management tool and will seek to identify problems requiring long-term or major commitments of resources and will recommend priorities for taking action. The final "Summary Report" will be prepared when all sites have been surveyed.

Mr. Bevill. The FY 1987 budget request for the Materials Production program in the Atomic Defense Activities appropriation includes $5 million for Project 87-D-156, Reactor Effluent Cooling Water Thermal Mitigation, at the Savannah River Plant in South Carolina. This project has a total estimated cost of $109 million. Has your organization reviewed this project to verify that it is a priority environmental activity?

Ms. Walker. In conjuncton with the preparation of the Department's FY 1987 budget, my organization reviewed Project 87-D-156 and determined that it is a high priority environmental project. That review was accomplished through the Environment, Safety and Health (ES&H) Ranking System that was developed as part of a program to evaluate ES&H projects in the budgetary process. Project 87-D-156 is a high priority project because it is needed to bring cooling water discharges into compliance with current environmental requirements.

ENVIRONMENTAL ACTIVITIES

Mr. Fazio. Is the Department on an environmental clean-up schedule consistent with those set forth in statute and EPA's program for federal agencies?

Ms. Walker. Although the Department has actual cleanup activities underway at several of its sites, most of our current efforts, with respect to inactive waste disposal areas, involve early stages of the cleanup process including site identification and associated preliminary assessment activities. Results from these activities will be integrated with the Environmental Survey, which covers all DOE facilities and all areas of environmental regulation and which is designed to provide the basis for the Department to establish priorities DOE-wide and to develop long-range planning and schedules for correcting environmental problems, including cleanups, and reducing potential risks. We believe this approach is consistent with requirements set forth in the Comprehensive Environmental Response, Compensation, and Liability Act and related regulations.

Mr. Fazio. What is the DOE schedule for clean-up at all your installations in current use? Have you any different priorities for no-longer occupied DOE sites which remain your responsibility, or inherited sites?

Ms. Walker. As discussed in the response to a previous question, the Department will establish schedules for actual cleanup projects as part of our overall effort to prioritize needed projects and to develop long-range plans for correcting environmental problems and reducing potential risks.

This approach is expected to also cover no-longer occupied DOE sites and inherited sites but will not affect any cleanup activities going on now at any of these sites, and, of course, it would not effect any cleanup activities associated with DOE programs such as the Formerly Utilized Sites cleanup projects.

Mr. Fazio. What is your institutional relationship with the EPA? Are you under its overall authority, working separately but cooperatively, working independently with little cross-communication or mutual policy setting?

Ms. Walker. Both the Department of Energy and the Environmental Protection Agency are instrumentalities of the executive branch of the Federal Government. Each has been charged by statute with a specific responsibility and mission. The Department of Energy is subject to many environmental laws and regulations and must comply with those laws and regulations to the same extent as nongovernmental entites. Even where the Department exercises authority for the safe and environmentally protective management of radioactive material under the Atomic Energy Act of 1954, it is still subject to general EPA radiation standards. Further, the Department of Energy must continually be aware and responsive to existing regulations and those in the development stage. The Department maintains management and staff level contact with EPA in order to communicate its interests and remain abreast of developments. The working relationship between the agencies may be formal or informal.

Formal mechanisms may involve interagency agreements, memoranda of understanding, joint action groups and so forth. As an independent agency of government, EPA has responsibility for setting policy in those areas delegated to it by the Congress or the President by Executive Order. Similarly, the Department of Energy sets policy in specific areas.

DOE coordinates compliance issues at its Headquarters and site locations with EPA Headquarters and Regional offices and States having authority for enforcing applicable laws or regulations.

HAWAII DEEP WATER CABLE

Mr. Akaka. Miss Fitzpatrick, when does the current contract for the Hawaii Deep Water Cable (HDWC) project expire and what will be the unexpended balance in the HDWC account on the date the contract expires?

Miss Fitzpatrick. The current contract with HECO is scheduled to expire on March 31, 1986, and the unexpended balance would be approximately $4 million (or 42.7% of the funds obligated to the contract) between DOE and the Hawaiian Electric Company (HECO). DOE Procurement Operations is in the process of extending the contract by three months. During this period, DOE will finish its review of the HECO proposed modification.

Mr. Akaka. Miss Fitzpatrick, does the Department intend to expend the balance of the funds in this account, and isn't it necessary to execute an extension of the existing contract or sign a new agreement in order to accomplish this?

Miss Fitzpatrick. Yes, DOE will expend the balance of the previously obligated funds ($9.354 million) remaining in the contract.

Yes, it will be necessary to modify the existing contract in order to extend its time and expend the remain funds. DOE reviewing options including how the unexpended funds might be employed to best bring the work to an orderly completion. To provide beyond the 3 month extension currently in process would require extension and negotiation.

Mr. Akaka. Miss Fitzpatrick, what will be the cost associated with not granting a contract extension or renewal?

Miss Fitzpatrick. The costs associated with not extending the contract could include close-out costs. Close-out costs have not been reviewed. To date, no long-term subcontracts (that upon termination would include close-out costs) have been awarded. However, in the unlikely event there are close-out costs, these would be determined by negotiations between DOE Procurement Operations and HECO following procedures established by Federal and DOE Procurement Regulations. It is nearly impossible to estimate what the close-out costs would be.

Mr. Akaka. Miss Fitzpatrick, what will be the savings associated with accepting the project sponsor's modifications, (e.g., reducing the scope of the at-sea test, etc.) compared with the cost of the program as originally proposed?

Miss Fitzpatrick. The originally proposed project statement of work included an extensive laboratory test program of the HDWC cable designed as part of the project and an at-sea test using the HDWC cable. The most recent estimate (Spring 1985) of this project (with original statement of work) is $35 million. HECO has estimated that its latest proposed modification will reduce this cost to $21.9 million. The modified project would still include an extensive laboratory test program of the HDWC cable design but the at-sea test is replaced by an at-sea test of a mechanical "surrogate" cable which would simulate the mechanical behavior of the laboratory cable. The majority of the savings of approximately $13 million of the modified project (compared with the originally planned program) are due to the savings associated with the modified at-sea test. DOE has not made a decision on the proposal versus other options which may be available.

Mr. Akaka. Miss Fitzpatrick, how much has been appropriated to date for the HDWC program and what will be the cost of completing all known requirements based upon the cost of the project if the modifications are accepted?

Miss Fitzpatrick. To date, a total of $10.754 million has been obligated to the HDWC program. Of this total, $9.354 million has been obligated to the prime contract with HECO and $1.4 million has been obligated to the support contract with the VSE Corporation.

The total cost of completing HECO's proposed modified project is $21.9 million. The estimated cost would not include costs for a follow-on support contract which historically has amounted to about 10% of the HECO contract.

Mr. Akaka. Miss Fitzpatrick, what is the status of (1) cable fabrication, (2) ocean engineering data collection, (3) the development of a laboratory test program?

Miss Fitzpatrick. The status of the above tasks are:

1. HECO's cable subcontractor (Pirelli Cable Corporation) is fabricating 6,000 feet of the selected cable design (self-contained, oil-filled submarine power cable). It has been determined that 6,000 feet of cable are required to perform the electrical and mechanical tests described in the laboratory test protocol. The cable fabrication is scheduled for completion in July 1986.

2. The oceanographic bottom survey cruise, for collecting measurements of actual bottom roughness of the Alenuihaha Channel was highly successful. The cruise started late in October and was completed on November 7, 1985. Good quality, high-resolution data was obtained which did not indicate the presence of any catastrophic bottom conditions to prevent laying a submarine power cable in the channel. Data reduction was completed and several potential cable routes have been identified where additional surveys should concentrate. Future bottom surveys will be conducted as part of the State program.

3. The development of a laboratory test program is well underway. A final draft of the laboratory test protocol, which describes in complete detail all the electrical and mechanical tests to be performed on the test cable,

has been prepared by Hawaiian Dredging (HECO's subcontractor) and issued. It is currently being reviewed by HECO and DOE. It is planned that the laboratory test protocol will be completed by May 1986.

Mr. Akaka. Miss Fitzpatrick, what activities would be undertaken in FY 1987 in the HDWC program if additional funding were provided by Congress?

Miss Fitzpatrick. DOE has not requested Congress to appropriate additional funds for the HDWC program in FY 1987. DOE believes that in these times of budgetary constraints the previously appropriated funds will suffice to complete the design and verification activities that are an appropriate Federal role in determining the technical feasibility of a deep water cable system for interconnecting the Hawaiian islands of Hawaii and Oahu.

Mr. Akaka. Miss Fitzpatrick, I know that you visited the Big Island of Hawaii last August to dedicate a facility at the Puna geothermal energy field. How does 1) the geothermal potential, and 2) the stage of geothermal development in Hawaii compare with geothermal activity elsewhere in the U.S.?

Miss Fitzpatrick. The geothermal potential on the Big Island appears to be very high, due to shallow magmatic heat sources and abundant rainfall. Particularly in the Puna field, it ranks with the best areas on the mainland. The stage of development in Hawaii lags behind the mainland, in part because of a mismatch between the center of geothermal potential and the center of population. However, work on new electrical transmission systems between the islands may help overcome that handicap.

PICHTR OPEN-CYCLE OTEC RESEARCH

Mr. Akaka. An Ambassador-level delegation from Japan is in Washington this week seeking the support of our government for joint research on OTEC. Miss Fitzpatrick, describe the PICHTR OTEC proposal for the Subcommittee.

Miss Fitzpatrick. The Department has not yet received a proposal from PICHTR. Our Ocean Energy Technology program has been, and expects to continue, supporting research and experiments at the Seacoast Test Facility in Hawaii. This has been cooperatively funded with the State of Hawaiis Department of Planning and Economic Development. We would consider carefully any proposal received from PICHTR, but at this time have no information from PICHTR on what the technical or administrative nature of such a proposal would be. We have just begun our discussions with the Government of Japan.

Mr. Akaka. Miss Fitzpatrick, describe the cost-sharing to be provided by the State of Hawaii, the Federal Government and the Government of Japan under PICHTR's project proposal.

Miss Fitzpatrick. Since we have not yet received proposals from either PICHTR or the Government of Japan, we cannot say what ratio of cost sharing would be negiotiated.

Mr. Akaka. Miss Fitzpatrick, how usual is it to obtain cost sharing as generous as this for solar & renewable energy research projects?

Miss Fitzpatrick. The renewable energy program has cost sharing activities in place, or in negotiation with external cost sharing ranging from a modest amount up to 75%. The amount of cost sharing in a potential proposal by PICHTR, or how these levels may compare to historical levels in renewable energy, is not yet clear. We always expect higher cost sharing ratios in more advanced stages of technology development.

Mr. Akaka. When does the Department intend to advise the Government of Japan whether it will participate with them in the PICHTR OTEC project?

Miss Fitzpatrick. The Department is developing plans for future upgrades and continued Ocean Energy experiments at the Seacoast Test Facility. We expect to have continued discussions with organizations of the State of Hawaii and the Government of Japan. The timing of any agreement will depend on when we receive proposals, the nature of the proposals, and the availability of funds and cost sharing.

Mr. Akaka. A Japanese delegation is in Washington this week to assess our government's commitment to jointly sponsoring research with Japan on Ocean Thermal Energy Conversion (OTEC).

It appears that the Japanese are prepared to make a funding commitment for their half of the project cost.

This joint research proposal represents an excellent opportunity to obtain one-for-one cost sharing on a major oceans energy research project.

Miss Fitzpatrick, are there any major obstacles to executing an agreement with the Japanese so that work can begin on this joint research project as soon as possible.

Miss Fitzpatrick. In any potential agreement of this type, the major issue is to develop a program with mutually satisfactory and equitable technological and other benefits for all parties, as well as appropriate sharing of costs. We plan to continue our experimental and upgrade program and while we view positively the opportunity to cooperate technically and financially with other parties, since we have not yet received any proposals, we do not yet know the magnitude of any obstacles to achieving an equitable agreement.

Mr. Akaka. Miss Fitzpatrick, is the Department prepared to meet its responsibility to provide its share of the costs of this joint research proposal?

Miss Fitzpatrick. We always try to ensure that we only enter into agreements that we can support; although since many activities are long term and it is difficult to predict out-year appropriations, it is not always. In this case, since we do not yet have a proposal, we do not yet know the magnitude of the costs involved.

HAWAII BIOFUELS PROGRAM

Mr. Akaka. The House report to accompany H.R. 2959, the Energy and Water Development Appropriation Bill for Fiscal Year 1986, allocates $500,000 of the funds appropriated for biofuels energy systems to the Hawaii Biofuels Program (H. Rept. 99-195, page 78). In addition, the conference report to accompany H.R. 2959 provides that "Report language included by the House which is not changed by the report of the Senate ...is approved by the committee on conference." (H. Rept. 99-307, page 5). This conference report language, as well as the colloquy between Chairman Bevill and myself during the debate preceeding the passage of the conference report (Congressional Record October 17, 1985, page H 8859), confirms that Congress appropriated $500,000 for the Hawaii Biofuels Program.

What steps has DOE taken to make a project award to the University of Hawaii in response to this direction from Congress? The University of Hawaii submitted its biofuels proposal in March 1985 so that work could begin soon after H.R. 2959 was signed into law. Ms. Fitzpatrick, has the department responded to the University of Hawaii's March 1985 biofuels proposal? If so, provide copies of their response for the record. Ms Fitzpatrick, when will the department make an award of the $500,000 grant to the University of Hawaii?

Miss Fitzpatrick. The Department has received a biofuels proposal from the University of Hawaii. The University was informed by letter of June 5, 1985 that the proposal had been received and was being fowarded

to the Office of Conservation and Renewable Energy for review. The proposal is currently under review for consideration on its merits for funding with FY 1986 appropriations. I expect this review to be completed in the near future. In addition, the Department is continuing to support several biomass research activities in Hawaii during FY 1986.

MOD-5B WIND TURBINE

Mr. Akaka. Miss Fitzpatrick, if your proposal to terminate the Mod-5B program is accepted, what will be the cost to the federal government to terminate the program? Include in your estimate the amount of revenues that will be lost if a completed turbine cannot be sold to Hawaiian Electric Industries, Inc.

Miss Fitzpatrick. We estimate the project can be closed out for about $1.3 million in FY 1986. This will involve terminating the Boeing contract except for report preparation, restoring the site in Hawaii and NASA management support for the project. The government will lose the $4 million over 25 years from the sale of the completed machine but this should be partially offset by anticipated revenues from sale of the uncompleted machine and scrapped tower.

Mr. Akaka. Miss Fitzpatrick, if the proposed deferral is rejected and the money must be obligated to the Mod-5B project, what is the total cost to complete the Mod-5B program?

Miss Fitzpatrick. We estimate $16.2 million in government funding will be required to complete the Mod-5B.

Mr. Akaka. Miss Fitzpatrick, describe 1) what work has been completed on the fabrication of the Mod-5B turbine, 2) how much site preparation work has been undertaken, 3) how much of the turbine has been erected, and 4) how much of the turbine is ready for shipment or is enroute to Hawaii.

Miss Fitzpatrick. Fabrication and assembly of the turbine rotor and nacelle is 95% complete. The foundation and tower have been installed in Hawaii. The tower errection except for painting is done. The generator, gearbox and some parts fabricated in Europe are in shipment to Hawaii. The machine nacelle and rotor assembled in Seattle, Washington were scheduled for shipment in April 1986.

RENEWABLE ENERGY

Mr. Conte. The Fiscal Year 1987 budget calls for an approximately 50 percent cut in funding for solar energy programs compared to the 1986 level. For each of the components of the solar program (photovoltaic, thermal energy, biofuels, wind energy, etc.) would you provide your initial request to the Office of the Secretary for 1987?

Miss Fitzpatrick. This information is provided for the record.

(Dollars in Thousands)

	FY 1987 A/S REQ.
SOLAR BUILDINGS ENERGY SYSTEMS	13,500
PHOTOVOLTAIC ENERGY SYSTEMS	48,000
SOLAR THERMAL ENERGY SYSTEMS	29,000
BIOFUELS ENERGY SYSTEMS	31,000
WIND ENERGY SYSTEMS	22,000
OCEAN ENERGY SYSTEMS	6,500
INTERNATIONAL SOLAR ENERGY PROGRAM	700
SOLAR TECHNOLOGY TRANSFER	5,000
SOLAR ENERGY RESEARCH INSTITUTE	11,000
PROGRAM SUPPORT	1,500
RESOURCE ASSESSMENT	1,500
PROGRAM DIRECTION - OTHER SOLAR ENERGY	5,300
TOTAL SOLAR ENERGY	175,000

Mr. Conte. When faced with cuts of the 50 percent magnitude for the solar program, was any consideration given to eliminating any solar energy technologies, rather than cutting more or less across the board? If so, which technologies were considered for elimination from the budget completely?

Miss Fitzpatrick. In each of the applied research and development areas, the need to accomplish reduced Federal outlays has prompted the Department to examine every funding proposal. Progress has been maintained in each area of solar and renewable technology since the 1985 timeframe. While significant advances bordering on breakthroughs have occurred in a number of areas; establishing the viability of these technologies as energy supply options will extend beyond the next few years. The Department has, therefore, proposed to maintain a reasonably balanced program in FY 1987 which addresses the highest technical and scientific priorities to facilitate moving forward in an orderly yet affordable manner.

Mr. Conte. For each solar technology, what will be the impact of the 1987 budget on your ability to meet the technology cost goals in your five-year and long range plans?

Miss Fitzpatrick. We do not expect a major impact on our five-year and long range plans as a result of budget reductions. While annual resources availability may have varied, and progress has changed some of the specific technical issues, the overall program priorities, have remained relatively constant over the past couple of years. The need to reduce Federal deficits has required a further focussing of Departmental proposals on those highest technical priorities most suited to the Federal role in energy research.

Mr. Conte. For each solar technology area, please provide a listing of the 1986 activities provided for in the appropriations act that will be reduced or eliminated in the 1987 budget?

Miss Fitzpatrick. A listing of solar activities for 1986 are as follows:

SOLAR ENERGY PROGRAMS
(IN THOUSANDS)

	FY 1986 ADJUSTED APPROP.	FY1987 REQUEST	DESCRIPTION OF KEY ACTIVITIES
SOLAR ENERGY:			
SOLAR BUILDINGS:			
APERTURE AND BUILDING SURFACE MATERIALS	$1,650	$1,200	Allow control over heat gain or loss & direct natural light deep into building interiors.
THIN-FILM POLYMER FOIL COLLECTOR	$390	$150	Low cost collectors in medium temperature range (140oF-180oF) water & space heating & desiccant cooling systems.
EVACUATED-TUBE COMPOUND PARABOLIC CONCENTRATOR (CPC) COLLECTORS	$250	$100	Very high efficiency,high temperature (200oF-400oF) collectors with applicability in solar cooling & & industrial process heating systems.
THERMAL STORAGE AND TRANSPORT MATERIALS	$900	$350	Improving thermal storage capabilities of conventional building materials & transporting energy by non-mechanical means.
CHILLER AND DESICCANT MATERIALS AND COMPONENTS	$1,310	$800	Analysis of open-cycle system concepts, development of an efficient integral collector/regeneration prototype, & evaluation of absorption chillers and refrigerant pairs.
SYSTEMS RESEARCH AND DEVELOPMENT (NON-RESIDENTIAL BUILDINGS)	$2,100	$1,200	Research directed at providing buildings industry with practical hearing, cooling, & daylighting solutions for nonresidential buildings.

SOLAR ENERGY PROGRAMS
(IN THOUSANDS)

	FY 1986 ADJUSTED APPROP.	FY1987 REQUEST	DESCRIPTION OF KEY ACTIVITIES
SYSTEMS RESEARCH AND DEVELOPMENT (RESIDENTIAL BUILDINGS)	$1,100	$900	Research directed at advanced active, passive, & hybrid heating & cooling systems capable of being integrated into multifamily & rehabilitation/ retrofit buildings.
SOLAR BUILDINGS CAPITAL EQUIPMENT	$481	$0	Various experimental apparatus.
PHOTOVOLTAIC ENERGY SYSTEMS:			
MATERIALS RESEARCH	$30,728	$19,600	Increase theoretical PV knowledge & to explore advanced materials having potential to meet PV program goals.
COLLECTOR RESEARCH	$4,345	$0	Evaluate & improve various types of solar/electric collectors (flat-plate concentrator).
SYSTEMS RESEARCH	$1,450	$0	Evaluate system performance & improve system/ application intertie.
PHOTOVOLTAIC CAPITAL EQUIPMENT	$1,155	$1,000	Assist in increasing theoretical knowledge and improve materials charactrization capability.
AUSTIN PROJECT	$2,000	$0	Fabricate & evaluate a 300kW PV system in Austin, TX.
MASS. INITIATIVE	$1,000	$0	Contribute toward newly forming Mass. Center having PV educational & outreach objectives.
SOLAR THERMAL ENERGY:			
COLLECTION TECHNOLOGY RESEARCH	$9,686	$6,900	Identify & characterize collection materials & components sutable for stable long-life performance in concentrating solar applications.

SOLAR ENERGY PROGRAMS
(IN THOUSANDS)

	FY 1986 ADJUSTED APPROP.	FY1987 REQUEST	DESCRIPTION OF KEY ACTIVITIES
CONVERSION TECHNOLOGY RESEARCH	$4,682	$2,800	Identify processes & components to convert thermal energy into electricity or other usable energy forms such as fuels and chemicals.
SYSTEMS TECHNOLOGY RESEARCH	$9,992	$5,350	Conduct system evaluations & comparative anaysis to assess potentail of alternate concepts, & to define critical technology & component issues.
PLANNING AND ASSESSMENT	$1,236	$250	Program integration, assessment, comparative analysis, program documentation & periodic contractor review meetings.
SOLAR THERMAL CAPITAL EQUIPMENT	$289	$0	Various experimental apparatus.
BIOFUELS AND MUNICIPAL WASTE TECHNOLOGY DIVISION:			
SHORT ROTATION INTENSIVE CULTURE	$3,600	$2,500	Identify/improve woody energy crops production.
HERBACEOUS ENERGY CROPS	$1,600	$1,400	Identify/improve herbaceous energy crops to be grown on marginal land.
AQUATIC SPECIES	$2,000	$1,300	Identify/improve high yielding oil producing species.
THERMOCHEMICAL CONVERSION	$8,900	$3,300	Develop processes to make fuels.
BIOCHEMICAL CONVERSION	$6,850	$3,100	Develop processes to make fuels. markets.
REGIONAL PROGRAM	$3,800	$0	Technology Transfer programs--four regions of U.S.

SOLAR ENERGY PROGRAMS
(IN THOUSANDS)

	FY 1986 ADJUSTED APPROP.	FY1987 REQUEST	DESCRIPTION OF KEY ACTIVITIES
WIND ENERGY SYSTEMS:			
ATMOSPHERIC FLUID DYNAMICS	$1,130	$1,050	Characterize & understand wind variability & local turbulence.
STRUCTURAL DYNAMICS RESEARCH	$3,800	$2,530	Measure, analyze & develop models for wind turbine structural stresses.
ADVANCED COMPONENTS RESEARCH	$4,518	$1,500	Examine components offering energy capture improvements or reduced structural mass.
SUPPORTING RESEARCH	$1,460	$1,000	Perform complementary research, analysis & tech transfer activities.
MOD-5	$11,547	$0	Advance technology of multi-megawatt wind turbines through research & design relating to a 3rd generation large turbine.
WIND ENERGY CAPITAL EQUIPMENT	$770	$170	Equipment to maximize ability to acquire data on wind resources, turbulance, aerodynamic loads & structural stress.
OCEAN ENERGY SYSTEMS:			
MATERIAL AND STRUCTURES RESEARCH	$530	$0	Evaluate materials fabricability & operating performance of selected OTEC components (currently heat exchangers.)
THERMODYNAMIC RESEARCH AND ANALYSIS	$1,211	$1,000	Analyze system performance, develop models, & bench-scale verify the thermodynamic performance of OTEC cycles.
EXPERIMENTAL VERIFICATION AND TESTING	$3,070	$1,500	Test in a marine environment critical OTEC components & systems at a scale useful to industry.

SOLAR ENERGY PROGRAMS
(IN THOUSANDS)

	FY 1986 ADJUSTED APPROP.	FY1987 REQUEST	DESCRIPTION OF KEY ACTIVITIES
SOLAR INTERNATIONAL PROGRAMS	$962	$500	DOC trade promotion events; DOE export technical assistance program. (CORECT)
SOLAR TECHNOLOGY TRANSFER	$2,983	$2,000	Technical reports & general fact-sheets; operate referral service.
SERI GENERAL PURPOSE PLANT PROJECTS	$1,993	$230	Permanent facility improvements (roads, safety).
SOLAR RESOURCE ASSESSMENT	$962	$700	Basic measurements & modeling-solar & wind resources.
PROGRAM SUPPORT	$1,251	$897	Crosscutting & special topic studies.
PROGRAM DIRECTION	$4,516	$4,100	Salaries & expenses for HQ FTE's (88 FY 86--70 FY 87)

Mr. Conte. With regard to solar and renewable research and development, what is your assessment of the current and projected role of the Solar Energy Research Institute (SERI)?

Miss Fitzpatrick. SERI serves a unique role as the lead solar energy research and development center. Currently SERI is the Nation's only major Federal research facility devoted exclusively to solar energy research. Due in large part to the Institute's multidisciplinary and technical capabilities and scientific output SERI has made a number of significant contributions to the advancement of solar technology. Through continued application of sound scientific and technical practices and research focus, the Institute's future efforts will continue to contribute to establishing solar energy technologies as viable energy-supply options in the decade to come. Assignments of research responsibility and fundings to SERI, as is the case with other research entities, will be periodically reviewed to ensure that the best match is continued between laboratory capabilities and program goals and technology objectives.

Mr. Conte. What will be the level of support for SERI from renewable energy programs for fiscal year 1987 as compared to 1986, and how will this reduced support affect SERI operations and programs?

Miss Fitzpatrick. Research which would be assigned to SERI would represent approximately 38% of the total Renewable Energy research funding request as opposed to 28% for FY 1986. Although this represents a $7.3 million reduction from the FY 1986 adjusted appropriation for research activities at SERI, this request represents a continuing commitment by the

Department to conduct a balanced research program across a broad cross section of solar technology options at SERI and reflects DOE allocations to areas of highest technical priority that are most suited to the Federal role in energy research and best match with capabilities of various research entities.

Mr. Conte. What role do you foresee for SERI in the long run as a part of the Department's solar and renewables program? How will long term funding prospects affect SERI's ability to maintain a critical mass of projects, staff and facilities in operation?

Miss Fitzpatrick. Due in large part to its scientific and technical capabilities and recent strides undertaken by the Institute to enhance managerial and technical performance, SERI has postured itself to meet the solar R&D challenges of the upcoming decade as we currently see them.

While all funding to institutions will be updated annually on the basis of best match between program objectives and laboratory capabilities; SERI will play an important role in the program for the foreseeable future.

Mr. Conte. What will be the impact of the 1987 budget on other (non-SERI) DOE laboratories involved in solar and renewables research?

Miss Fitzpatrick. Within the context of available resources renewable energy will provide funding to DOE laboratories based upon the highest priorities to meet program goals and objectives. While funding levels will require selectivity, essentially research activities will continue commensurate with established funding levels. Assignments of research responsibility and fundings to laboratories, as is the case with other research entities, will be periodically reviewed to ensure that the best match is continued between laboratory capabilities and program goals and technology objectives. FY 1987 non-SERI laboratory funding for solar and renewable energy programs is planned as follows:

($ in thousands)

Laboratory	FY 1987
Argonne National Laboratory	$ 1,662
Brookhaven National Laboratory	2,196
Los Alamos Scientific Laboratory	5,600
Lawrence Berkeley Laboratory	4,370
Idaho National Engineering Laboratory	1,075
Lawrence Livermore Laboratory	91
Oak Ridge National Laboratory	6,085
Pacific National Laboratory	4,811
Sandia National Laboratory	17,516
Total	$43,406

Mr. Conte. How does the fiscal year 1987 budget provide funding for cross-cutting, long range, exploratory research in the solar and renewables area?

Miss Fitzpatrick. In a number of instances program funds are expended in basic areas that cross-cut various technical program areas. Progress has been maintained in renewable energy technologies while significant research advances have been made in a number of renewable energy program areas. The Departmental request for renewable energy reflects a commitment to sustaining a balanced effort among the renewable energy technologies options in a manner which focuses expenditures on the highest priority for scientific and technical investigations. Our priorities emphasize longer range exploratory research in each technology area.

Due to the diversity of renewable energy technologies, there is a range of fundamental issues to address. They may range from basic materials related issues such as structural integrity of reflective surfaces, or conversion efficiency of photovoltaic materials; to resolution of wind technology reliability and durability issues through advancement of underlying structural and aerodynamic theory; to resolution of environmental uncertainty attendant to combustion of municipal wastes; to feasibility of using magma energy as a geothermal energy source for power generation.

Mr. Conte. What resources are available this year and under the 1987 budget to support a university that wishes to strengthen and expand its wind engineering program?

Miss Fitzpatrick. University participation in our research program is encouraged. For example, the Solar Energy Research Institute recently completed a university research solicitation for wind research in which many excellent proposals were received. SERI expects to periodically issue such solicitations, and we encourage Universities to submit proposals in response to those solicitations. In addition, SERI, Sandia, Battelle, and Headquarters periodically seek university expertise on specific topics and university researchers to serve on review panels and advisory groups.

BIOFUELS

Mr. Conte: As you know, the regional biomass program has been a particular interest of mine. What level of funding is each regional program receiving this year, and what is projected for 1987? Would you also provide a brief summary of the status and activities of the program in each region?

Miss Fitzpatrick. The total level of funding for FY86 is $3.4 million with the Northwest, Southeast, Northeast and Great Lakes regions getting $1.2 million, $0.95 million, $0.695 million and $0.555 million respectively. There have not been any funds requested in FY 1987. We believe that a useful ground work has been laid with previous year's funding, and that the regions will be able to make use of that work for their own purposes in the future.

Regarding the status and activities of each region, there are a number of activities that are applicable to each region. Organizational structures were designed and implemented to direct and manage the respective Regional Programs. Technical groups of experts, consisting of representatives of appropriate federal, state and regional agencies, university researchers, and private industry, have been formed to provide guidance and assistance in identifying regional issues and planning program activities to address those issues. Resource assessments have been completed or are underway in each of the regions. The Southeastern Region, for example, has recently completed and published a comprehensive assessment and quantification of woody biomass resources across the region. Cooperative projects have been undertaken with each of the states in the respective regions to expand state-level involvement in biomass energy and to promote program integration and cooperation

within and between states. Competitive solicitations have been let for the conduct of technical studies, the production of information products, and the demonstration of biomass technologies in industrial/commercial applications.

Now as for activities specific to each region, in the Northwest, the abundant forest resource has focused biomass energy interest on wood. The large quantities of non-commercial timber, along with the residues generated from commercial logging operations, present a tremendous opportunity for biomass energy utilization, yet also pose unique problems related to the economic and technical feasibility of harvesting such material. The Northwest Region is supporting the development of new concepts in residue recovery and steep-slope harvesting, investigating the environmental impacts of residue utilization, and working to quantify both the absolute and economic availability of residues.

The Northeast Regional Biomass Energy Program also places emphasis on wood energy, both industrial and residential. The program has studied the regional economics of wood energy development and its effects on forest management and the wood fuel supply. In addition, the program has provided direct technical assistance to a number of industrial and commercial entities converting from conventional to wood-fired energy systems. Co-firing of multiple fuels is another technology area of interest to the Northeast, where an assessment of wood/coal co-utilization has recently been completed and the feasibility of co-firing wood with municipal solid waste will be studied under the FY 1986 program. A two-year project to monitor and evaluate the emissions released from catalytic and high efficiency woodstoves has just

recently gotten underway in New York and Vermont and is generating much interest from state environmental regulatory officials, the U.S. Environmental Protection Agency (EPA), woodstove manufacturers, and others with a stake in residential wood combustion. The project focuses on instrumenting and collecting data from stoves in "real world" household use. It is expected that the results of the project will have a direct impact on EPA's development of New Source Performance Standards for emissions from residential woodburners. The program is receiving co-funding and support for this work from the EPA, the New York State Energy Research and Development Authority, the Vermont Agency for Environmental Conservation, the New York State Department of Environmental Conservation, the Wood Heating Alliance and the Northeastern States for Coordinated Air Use Management.

In the Great Lakes Region, informational barriers have been identified as a major impediment to widespread understanding and adoption of biomass energy technologies. Consequently, 1986 activities of the Great Lakes Regional Biomass Energy Program center on educational out reach. Contractors are being solicited to conduct five series of workshops on the following topics: wood energy for industrial and commercial energy users; wood energy for architects and engineers; agricultural residues for energy; short-rotation forestry; and waste-to-energy. In addition, a handbook will be developed to present, to regional policymakers, the current state-of-knowledge with respect to the environmental effects of harvesting the forest for energy. Recently completed activities include a number of information development and dissemination projects, including resource assessments, a directory of biomass energy facilities in the region, and a guidebook to residential wood combustion safety and emissions. Applied

research has also been supported in such areas as the development of biomass fuel standards, methods for drying high-moisture biomass fuels, and the regional economic impacts of biomass energy production and utilization.

Information development and dissemination is also a major activity of the Southeastern Regional Biomass Energy Program. Currently in progress is the production of a series of case study factsheets on successful biomass facilities in the region, along with several handbooks and manuals on such topics as: cogenerating with biofuels; financing options for biomass energy systems; investment decision-making; and environmental issues and requirements. The Southeastern Program is also very active in promoting the installation of biomass energy systems in public facilities and private industries. Applied research supported by the program has covered a range of biomass energy technologies such as bio-methane production, alcohol fuels, wood gasification and biomass fuel processing.

In conclusion these activities indicate that this program has achieved its objective and that the regions now have the capability to plan and carryout this program in a manner that best addresses the biomass issues of their respective region.

Statement of Donna R. Fitzpatrick
Assistant Secretary
Conservation and Renewable Energy
Department of Energy
FY 1987 Appropriation Hearings

Mr. Chairman and Members of the Subcommittee:

I appreciate the opportunity to appear before you today and discuss the FY 1987 budget request concerning the Department's Renewable Energy and Electric Energy Systems and Energy Storage programs. The budget for these programs is consistent with the goals and objectives of national energy policy and is fully responsive to the Administration and Congressional goals of deficit reduction.

The Administration's overall energy goal is to foster an adequate supply of energy at reasonable cost. We can achieve that goal through the combination of energy stability, energy security, and energy strength. Energy stability has been achieved over the past five years. Our energy security is growing stronger day by day. Our objective for the immediate future is to build this Nation's energy strength, making full use of its vast natural resources and the daring and ingenuity of its citizens. Our approach includes supporting advances in energy conservation as well as possible energy supply sources of the future such as renewable energy.

Deficit reduction is perhaps the preeminent domestic economic imperative today and the Department fully recognizes that fact. For this reason, we are doing all we can to concentrate increasingly scarce resources on those programs and projects that directly fulfill a responsibility of the Federal

government and truly require Federal assistance. If we are to achieve our overriding goal of deficit reduction we cannot afford to continue to allocate scarce Federal resources to activities where the rationale for continued Federal involvement is weak and where State and local organizations or private industry can and should take over responsibilities presently borne by the Federal government. Also, we cannot permit programs or projects to continue with Federal support unless they meet a high priority national need. We have no choice under the current and necessarily strict fiscal regimen but to concentrate scarce resources where they show promise of bringing the greatest benefits.

As we seek ways to gain the greatest benefit from our limited resources, we will investigate cooperative research and development ventures with private industry consortia. This approach to R&D funding has the potential to provide greater leverage of Federal funds and to assure that resources for applied R&D are focused on high priority areas where there is private commitment to follow through with promising technologies. It can also foster increased technology transfer by involving industry earlier in the R&D sequence. One of our early steps will be the publication of a general solicitation of industry interest in forming R&D ventures in the various conservation and renewable energy program areas.

In order to contribute to the achievement of our goals, the FY 1987 budget request for Renewable Energy, Electric Energy Systems, and Energy Storage programs will continue to support development of a mix of technologies that can contribute to both energy supply and improved end-use

efficiency. The FY 1987 budget request for Renewable Energy R&D programs under this subcommittee's jurisdiction totals $108.0 million; $16.2 million for Electric Energy Systems and Energy Storage, $90.2 million for Renewable Energy programs and $1.5 million for general policy and management support.

RENEWABLE ENERGY OVERVIEW

The availability of stable and secure sources of energy will continue to play an important role in sustaining a robust domestic economy. The Department's renewable energy programs reflect a continuing national commitment to diversify U.S. sources of energy supply in a manner that fosters free market choices. Renewable energy can be an important part of the nation's energy supply mix and renewable technologies are already making important contributions to national, regional, and local energy requirements. These contributions are possible since the family of renewable energy technologies spans a wide range of resource and technical options at varying stages of maturity. Some technology and resource combinations have been providing substantial energy for many years, others are just beginning to enter the supply system, and some remain in research phases.

Renewable energy technical progress has been paralleled by an increasing level of confidence in and commitment to these technologies by the private sector. The renewable industry has made significant progress in recent years to its development into the diverse group of many small businesses and sizable divisions of large companies that we see today. There has also been progress with respect to the other institutions concerned with renewable energy supply and use. States have become increasingly involved with

promoting renewable energy use, while universities, research institutes, and utilities are promoting awareness and conducting programs to further advance our knowledge of renewable energy potential.

Within the current Federal budget limitations, it is the Department's objective and role to participate in the highest priority research to address the most critical technology base issues. The focus of such efforts will be on those technologies with the greatest long-term promise for contribution to the nation's energy supply mix. These efforts will emphasize precompetitive research critical to advancing technology while avoiding interference with the extraordinary capacity of industry to develop specific commercial products and services. The Department will continue to encourage private sector participation and leadership and will seek input from industry and other institutions in the selection of projects which have the greatest relevance and potential.

SOLAR BUILDINGS

Solar buildings technologies have continued to make inroads in housing and, to a lesser degree, in the commercial buildings sector. These technologies can presently supply up to 40% of the energy required to heat individual homes across the United States. There is increasing scientific evidence that such energy contributions could be doubled and extended to additional types of building requirements for energy supply by means of continued opportunity for technological innovations. The FY 1987 Solar Buildings Technology Program budget request of $4.7 million for operating expenses will provide industry with an essential technology base for developing the new materials, components, and technologies required to realize this potential.

Working closely with industry and university laboratories, the Solar Buildings Program is conducting long-term, cross-cutting research which the diverse sectors of the industry cannot support. The goal of these research activities is to increase the energy contribution of solar technologies to the point where 70% to 80% of space heating, hot water, cooling, and lighting requirements of various types of buildings could be supplied at costs that are competitive with conventional fuels.

The FY 1987 program in materials and components includes continued research on new optical and thermal switching films that control solar gain and thermal losses for windows and exterior building surfaces. Research on innovative collectors will increase their thermal efficiencies and reliability, decrease their cost, and expand the application of active solar technologies to cooling systems and other building energy requirements.

New phase change materials incorporated in such conventional building materials as wallboards will make it possible to store and use thermal energy provided by solar energy in all parts of the building. Advanced thermal transport concepts will enable energy to be transferred from the point of collection at the building exterior to any interior location, thereby improving the energy performance of solar building systems.

Systems research activities encompass both residential and non-residential building applications. Research on open cycle solar absorption and solar desiccant cooling technologies will be aimed at increasing their energy efficiencies, the key to achieving viable solar cooling applications. An important element of the FY 1987 systems research program is the development

of analytical tools to allow architects and engineers to predict system performance. Researchers will also continue to monitor, analyze, and evaluate the performance and reliability of solar building technology. Analysis techniques are being developed for integrating these solar technologies with conventional heating and cooling systems.

PHOTOVOLTAICS

Photovoltaics (PV) is on its way to becoming a significant energy supply option. The partnership between DOE and industry has resulted to date in rising conversion efficiencies, increasing reliability, and lower costs, all of which have helped the technology to establish a strong foothold in the competitive energy market, with a broad range of viable applications. In FY 1987 the Photovoltaic Program, with a budget request of $19.6 million for operating expenses and $1.0 million for capital expenses, will seek to advance the basic understanding of technical issues associated with materials formation and physical phenomena of the PV cell.

Amorphous silicon is an attractive thin-film photovoltaic material that could establish PV technology as a broadly competitive electric power production option. U.S. research leads worldwide efforts in addressing the issues leading to the optimization of single junction submodules and the investigation of higher efficiency multijunction concepts. The efforts will lay the ground work for a viable industrial effort capable of achieving 10 percent efficiency single junction and 13 percent multiple junction large area submodules.

Polycrystalline thin films also represent promising candidates for meeting the major programmatic criteria relating to cell efficiency, material processing requirements, and performance stability. Progress has been made in the development of low cost deposition methods, and in cell efficiency. FY 1987 efforts will concentrate on defining the scientific and technological barriers to approaching theoretical efficiency and on the development of large area film fabrication concepts for the most promising of these materials.

As a result of DOE's program, single-crystal gallium arsenide and single-crystal silicon solar cells currently hold records for the most efficient photovoltaic conversion of sunlight to electricity. But the efficiency of such materials is inherently limited because not all incident sunlight can be utilized due to the frequency selectivity of the specific materials involved. To overcome this difficulty, researchers are exploring concepts that will include seeking improvements in selected single-junction cells as well as studying concepts to mechanically or optically couple cells or to fabricate, as one structure, two or more cells of different materials. The goal of this high priority effort in high efficiency concepts is to achieve 35% efficient small area cells for use by industry as part of its development effort.

The FY 1987 program will also maintain its unique capability for precise measurement of material and cell parameters. This work at SERI guides researchers throughout the U.S. in understanding and correlating observed physical phenomena. The program will also support other fundamental research in quarternary and ternary compounds, and promote basic material work at

universities. Finally, the wealth of information gathered by the program from materials to systems during its ten years of research and development will be used to assist industry in its efforts to bring photovoltaic technology to competitive maturity, domestically and internationally.

SOLAR THERMAL TECHNOLOGY

The technology base for solar thermal technology has dramatically improved as a result of significant achievements within the last two years. These achievements include substantial system cost reductions and performance enhancement due to the research in advanced solar thermal components and subsystems which resulted, in part, from DOE's cooperative efforts with industry. At present, solar thermal technologies are capable of delivering electricity at 13¢/kWhe. However, solar thermal technology must be capable of 5¢/kWhe for electric power production and $9/MBtu for thermal energy in order to be competitive with a mix of other energy generating technologies. The FY 1987 program, with a budget request of $15.3 million for operating expenses, emphasizes activities which address the component and subsystem improvements/advances necessary to approach these objectives. Heliostat sizes have increased three- to four-fold, while costs have been reduced by 40% since Solar One (Barstow) became operational in 1982. The stretched membrane concept has the potential to further reduce the heliostat field and parabolic dish concentrator costs by another 50%. The FY 1987 research will continue the design and testing of these advanced concepts.

Central receivers using molten salt or sodium as heat transfer fluids would allow reductions in the size of advanced receivers and enable the development

of low pressure receivers that are lighter in weight with lighter support structures. The new fluids can also be stored at high temperature and low pressure for plant operation during long hours of reduced insolation. Research efforts in this area to-date have established the basis for reduced receiver and storage costs by 50%, improving both the overall plant cost and levelized energy costs of solar thermal systems. The development and testing of these advanced subsystems will continue through FY 1987. The Vanguard dish module has proven the high conversion efficiency of sunlight to electricity by achieving a 29% net (31% gross) system efficiency using a kinematic Stirling engine. Development of the free-piston Stirling engine concept, in cooperation with NASA, will continue in FY 1987. This engine has the potential to achieve the long-term goals of high reliability and performance at competitive cost. Additional research projects which are underway and will continue in FY 1987 include the development of a thermochemical cell in which spent chemicals would be regenerated by solar energy to produce electricity. Additionally, several present methods for producing solar thermal electricity generating systems are limited to operation below 750°F due to excessive thermal losses. Researchers will continue to study approaches for replacing the sensible heat transport methods with thermochemical energy transport and storage processes which have the potential to dramatically reduce thermodynamic losses and thereby increase overall efficiency. Experiments addressing the technical feasibility of thermochemical transport will also be undertaken.

BIOFUELS

Biofuels energy technologies utilize a variety of organic feedstocks, such as terrestrial and aquatic crops and municipal waste, which can be converted by

thermochemical and biochemical processes into high-value gaseous, liquid, and solid fuels. Biofuels currently are supplying approximately 2.7 quads or almost 4% to the U.S. energy supply. Development of advanced biofuels technologies offers the potential for significant additional contributions over the longer term. The FY 1987 budget request for Biofuels Energy Systems is $11.6 million for operating expenses and $0.6 million for capital equipment. During FY 1987, the Biofuels Program will focus on key long-range research and development issues to provide a technology base for private sector development of biofuels production and conversion technologies.

Feedstock production research supported within the Budget Request in short-rotation intensive culture will include genetic selection to improve biomass yields, along with examination of monoculture plantings to determine operational yields and susceptibility to disease and pests. Research on herbaceous energy crops will focus on screening of promising species that can be grown on marginal croplands, as well as small-scale experimental plots. Aquatic species research will include species screening, genetic research, and small-scale experiments to improve the productivity of microalgal species and the efficiency of conversion processes.

Thermochemical conversion research will focus on liquefaction and pyrolysis of biomass feedstocks to produce high-value liquid and gaseous fuels. Municipal solid waste research will continue to address the production of liquid and gaseous fuels via thermal liquefaction and gasification. Combustion kinetics and emissions research will also be conducted.

Research in biochemical conversion will focus on improving processes for

conversion of organic materials to alcohol fuels in order to advance the technology for competitive production of octane enhancers and additives for transportation fuels. Research in the anaerobic digestion of municipal waste will address the improvement of microorganisms, as well as attempt to understand the biochemistry and physiology of the anaerobic digestion process.

WIND ENERGY

Updated information, recently received, indicates that there are presently over 13,000 wind turbines operating in the U.S. with an installed capacity greater than 1100 MW. However, many areas remain where continued research efforts are needed to establish the knowledge base necessary for industrial development of viable wind technology within the context of evolving competitive and unsubsidized electric energy supply markets. It is the objective of the Wind Energy Research Program to improve the understanding of fundamental atmospheric fluid flows and their effects on wind turbines and to translate this understanding into tools that industry can use to design and develop improved, more reliable, cost competitive wind turbines. The FY 1987 budget request of $8.1 million for operating expenses and $.2 million for capital equipment will fund the research required to accomplish these objectives.

Commercial development that started at the 50 kw size has now moved into the 100-200 kw range. With the success of those tests and the current successful operation of the larger Mod-2 experiments, sufficient data is now available to industry to proceed with larger systems. The large experimental Mod-2 and Mod-5 projects will be closed in FY 1987 to concentrate resources on fundamental structual and aerodynamic research to benefit all system sizes.

Major improvements in turbine energy capture are believed to be achievable through aerodynamics research activities. Tests on specially instrumented commercial machines will continue in order to collect actual operating data in a wide range of environments. This will improve the understanding of the performance of different turbines' energy capture as it is affected by turbulence, wakes, and micro-siting and will further the development of air foils tailored to wind turbine requirements.

FY 1987 structural dynamics research activities will improve the understanding of how aerodynamic loads induce structural stresses and rotor and tower material fatigue. Research efforts are aimed at the development of predictive models which take into account the complex interactions of forces on wind machines. Cooperative field assessment activities with industry are used in this area to acquire the data necessary to verify theories.

Advanced component development involves the application of basic science and research on aero and structural dynamics to develop components that could lead to major improvements in the energy production of advanced wind turbines. This area also includes studies on environmental effects of wind turbines, application of wind turbines as fuel savers with diesel generators for remote power generation, and on the interaction of wind machines with existing utility power systems.

OCEAN ENERGY

The Ocean Program conducts the research and development of ocean energy technology to a point where the private sector can make competent assessments

of whether applications of the technology are viable energy supply alternatives. This will be accomplished through appropriate research on components and systems modelling. The OTEC program is guided by a long-range goal to investigate the technologies which could reduce the capital cost of the OTEC systems to $3200/kWe (1984 dollars). The program strategy focuses on reducing the technical uncertainties associated with a 5-15 MWe, near-shore OTEC system which serves as an approximation of the incremental capacity requirements of the type of markets representing the likely point of initial competitiveness for this technology. The FY 1987 budget request is $2.5 million for operating expenses.

The emphasis of the FY 1987 Ocean Program will be placed on experimental verification and testing and thermodynamic research and analysis. Material and structures research and oceanographic, environmental, and geotechnical research previously undertaken have provided a data base that is useful for the two FY 1987 research areas, but do not currently require the degree of emphasis that was necessary in past years.

The objective of the experimental verification and testing program is to provide a facility for private industry to conduct seawater tests and experiments which verify OTEC component functional feasibility, performance, and operational characteristics on a scale which can be extrapolated for use in modular systems applicable to small plants. The FY 1987 budget will also provide funds to upgrade the Seacoast Test Facility by expanding the capacity of its seawater systems for open-cycle OTEC experiments.

One objective of the thermodynamic research and analysis program is to

experimentally determine the effects of seawater and non-condensible gas on open-cycle heat and mass transfer processes. The program will also validate selected power system analytical models at a scale sufficient to extrapolate a generic understanding of how to design potentially cost- effective open and latent-heat power systems which could meet the cost goals of the program. Reaching this goal is dependent upon increasing the output of the power system and significantly reducing the life cycle cost.

OTHER SOLAR ACTIVITIES

The FY 1987 budget request for the efforts in support of planned research activities is $8.1 million for operating expenses and $.6 million for capital equipment. These efforts include international, technology transfer, and resource assessment programs, the Solar Energy Research Institute, and program support and direction.

Technology transfer activities such as publications summarizing research results across individual investigations and performing centers are important mechanisms for transferring information to the R&D community in context and provide the basis for facilitating information exchange and dialogue. Additionally, continuing requests are received for information from a more general cross section of the public and the energy community concerning renewable energy. The FY 1987 budget request of $1.9 million for operating expenses and $.1 million for capital equipment will continue the technical and public information services at levels commensurate with solar research and development activities.

The international solar energy program provides Federal organizations and industry with a vehicle for cooperative international trade development for renewable energy. DOE is responsible for chairing an interagency committee, the Committee on Renewable Energy Commerce and Trade (CORECT) which provides a forum where industry and public entities can coordinate the use of existing resources and authorities to exploit export opportunities for the domestic solar energy industry. Additionally, funds are used to conduct a program managed by the Department of Commerce which cost shares, with industry, the development and presentation of exhibitions, special trade missions and trade development services with a continuing focus on international markets of more significant potential. The FY 1987 budget request is $.5 million for operating expenses.

The FY 1987 budget request of $.5 million for the Solar Energy Research Institute will fund capital improvements to the permanent DOE facilities that will improve efficiency, safety and security.

Solar resource assessment activities will provide information regarding the distribution and spectral, and temporal variability of solar energy resources throughout the United States. The FY 1987 budget request for these activities is $.7 million. Coordination of these activities and other ongoing research and development activities is an important part of the program support and direction functions. FY 1987 requests of $.9 million for program support and $4.1 million for program direction funds will, among other things, provide technical and crosscutting studies of the various solar technologies, provide for updates to multi-year program plans, continue technical and programmatic dialogue with industry, and manage the diverse research activities in the national solar research program.

GEOTHERMAL ENERGY

The Geothermal Energy Program carries out research and development, in cooperation with industry, on an array of geothermal resource types (including geopressured, hydrothermal, hot dry rock, and magma) and conversion technologies designed to define the technical and economic boundaries of this vast domestic energy supply resource. Program activities include applied research, technology development, and information efforts which provide the basis for the timely introduction of new concepts and products into the marketplace by the private sector. The FY 1987 budget request for the Geothermal Program is $17.9 million for operating expenses.

The purpose of the geopressured research program is to define the technical characteristics and recoverability of this large resource of hot brine and methane which lies primarily beneath the U.S. Gulf Coast. The FY 1987 program includes experimental well flow testing, tests of the conversion of the combined energy content (thermal and chemical) to electricity, and supporting research on the dynamic response of geopressured reservoirs to production conditions, chemical constituents of the brine, and the possibility of land subsidence.

Hydrothermal research will allow the expansion of the accessible resource base through an improved understanding of the processes for extraction and reinjection of geothermal fluids; new materials capable of withstanding high temperatures, high pressures, and highly corrosive environments; brine chemistry research leading to techniques to prevent plugging of wells and pipes; advanced power cycle technologies; field testing techniques for

appraising very high temperature geothermal resevoirs at the Salton Sea Scientific Drilling Project; and the experimental study of survey methods applicable to young and andesitic volcanoes.

Hard rock penetration research will be performed jointly with industry to improve the technology and reduce the uncertainty of geothermal well drilling, that currently represents about half of the cost of geothermal power and exceeds the cost of typical petroleum wells by factors of two to four due to the fact that geothermal wells are generally deeper, and encounter harder rock, higher temperatures, and more corrosive fluids than do oil and gas wells. Experimental programs include high-pressure water jets combined with rock cutters, mechanics of rock penetration, and drilling fluid loss control.

Research will also be carried out to determine the depth and size of a large continental magma chamber, to evaluate alternative methods of energy conversion, and to develop materials and instrumentation capable of operations in the 1000 degree Celsius magma environment.

Hot dry rock research involves the evaluation of the properties of deep crystalline rock and the development of methods to extract geothermal heat from such resources. In FY 1987, the experimental extraction of heat from the large fractured reservoir at Fenton Hill, New Mexico, will begin and research on improved diagnostic technologies including microseismic measurements will be extended to higher temperatures.

GEOTHERMAL RESOURCES DEVELOPMENT FUND

The Geothermal Resources Development Fund was established to broaden the geothermal energy technology base by guaranteeing loans for private sector development of several state-of-the-art facilities. The FY 1987 request is $72,000, which allows for evaluating projects, restructuring existing guarantee agreements, and monitoring outstanding loans.

HYDROPOWER

Small-scale hydropower technology is nearing maturity, and the DOE program has succeeded in providing the necessary technology base to industry. Therefore, no funds are requested for FY 1987. Ongoing contracted analytical and technical support will begin to phase out. The remaining technology development and R&D projects will then be monitored by DOE personnel to ensure that contractual and reporting requirements are met. By the end of FY 1986, seventeen of the nineteen technology development projects will be on-line, with the remaining 2 becoming operational in FY 1987. The low-cost crossflow turbine and free-flow turbine R&D projects are expected to go on-line in FY 1986 and the siphon penstock R&D project will be operational in FY 1987.

ELECTRIC ENERGY SYSTEMS

The Electric Energy Systems Program conducts research to establish a technology base that will lead to advanced concepts and materials that will enable future electric networks to meet the national security need for a reliable electric supply while maintaining the health and safety of society.

The Program supports research to resolve mid-to long-term problems in order to ensure that the biological health effects and risks to life forms exposed to high-voltage electric and magnetic fields are well understood and mitigated; to provide options that will ensure appropriate system reliability and promote the efficient use of resources in the Nation's future electric network; provide electric power over a wide range of system conditions including both normal and emergency situations, and to improve the efficiency of electric systems through the development of new materials, advanced controls, and new design concepts. The FY 1987 budget request is $7.6 million for operating expenses.

Researchers in reliability R&D activities will continue to assess the potential impact of a nuclear electromagnetic pulse on the Nation's electric network and to provide advanced techniques for control and protection of systems during normal and abnormal operations. In FY 1987 the reliability research will include a second-level impacts assessment.

Funds requested in the systems technology research activity are required to meet contractual obligations to complete several current programs. New materials research will be carried out on liquid dielectrics and semiconductors.

ENERGY STORAGE

The Energy Storage program is developing a technology base for advanced energy storage and conversion systems that will facilitate the use of abundant but intermittent energy sources. Three promising energy storage technologies are now being pursued: battery (electrochemical), thermal, and

chemical/hydrogen. The FY 1987 budget request for the Energy Storage program is $8.6 million.

The battery storage technology base research activities encompass fundamental research with the objective of providing the basis for improvements in efficiency, power density, energy density, and lifetime in new electrochemical couples and small-scale fuel cells. In FY 1987, the aims of the technology base research will be to provide a better understanding of the complex phenomena that determine electrochemical activity; explore new electrochemical couples with improved performance characteristics; develop improved materials and new components for advanced battery technologies to solve key technical problems; and identify new, low-cost catalysts for electrochemical energy conversion systems.

The objectives of the advanced development activity include development and evaluation of high-performance, long-life, economical batteries for future mobile and stationary energy storage applications. In FY 1987, the exploratory technology development activities will concentrate on investigating key problems in sodium/sulfur batteries which have the potential for providing up to five times the energy storage capability of conventional batteries. Research will include identifying new materials and designs for electrolytes and electrodes.

The thermal and mechanical energy storage activity will provide the technical underpinning for the more effective use of thermal energy sources and improving the efficiencies of chemical/hydrogen production and storage. Activities in FY 1987 will emphasize chemical/hydrogen research on

high-temperature electrolysis and advanced storage options to achieve lower cost in hydrogen liquefaction. The thermal storage program will conduct research on form-stable phase-change materials in the high-temperature range and will explore advanced storage concepts.

CONCLUSION

Mr. Chairman, I believe that the budget that I have summarized will contribute to increased energy supply diversity and end-use efficiency and should serve to promote increased competition in the marketplace. I believe that this budget request will allow us to address the items of highest priority in research and development in the fields of renewable energy and electric energy systems and energy storage thereby contribute to the accomplishment of our national goal of fostering an adequate supply of energy at reasonable cost. This is a budget which I believe seriously recognizes today's fiscal responsibilities, as well as tomorrow's anticipated needs.

Thank you for the opportunity to present our budget request.

U.S. Department of Energy
Assistant Secretary for
Congressional, Intergovernmental
and Public Affairs
Office of Public Affairs
Washington, D.C. 20585
202/252-5644

BIOGRAPHY

DONNA R. FITZPATRICK

Donna R. Fitzpatrick was nominated by President Reagan on July 31, 1985, and confirmed by the Senate on December 19, 1985. She was sworn in as Assistant Secretary for Conservation and Renewable Energy, U.S. Department of Energy (DOE) on December 20, 1985. She had served as Acting Assistant Secretary since March 11, 1985, and as the Principal Deputy Assistant Secretary since January 1984.

In this position her responsibilities include management of research and development programs in energy efficiency and alternative fuels for industry, buildings, and vehicles. The programs in renewable energy resources involve research in active and passive solar, photovoltaic, wind, ocean thermal, geothermal, and biomass technologies. In addition, she administers federal grant programs for low-income home weatherization and energy efficiency improvements in schools and hospitals, and coordinates management of three of the five federal power marketing administrations.

In 1983, Miss Fitzpatrick served on a consultant team for the Secretary of Energy to conduct a general review of the Department's conservation and renewable energy programs, focusing on policy, program goals and priorities, budget levels, and new initiatives. In 1980, she served the Office of the President-elect as a member of the Transition Team for the National Science Foundation, reviewing national policy in basic science research, project efficiency, funding, and proposed legislation.

In her law practice, first with the Washington, D.C., firm of O'Connor and Hannan and then as a sole practitioner, Miss Fitzpatrick worked extensively on real estate development, helping to coordinate public and private interests and activities where Federal and District of Columbia involvement was required. This included work with local utilities and engineering planners to determine the legal, economic, and technical feasibility of various energy options, such as solar, cogeneration, and an on-site power generation and district heating system for large scale, high density residential and commercial uses.

Miss Fitzpatrick is also experienced in civil litigation, including administrative law and contracting issues.

Miss Fitzpatrick received a Bachelor's degree in physics cum laude from the American University in 1972. After teaching high school chemistry and mathematics, she entered law school and graduated from the National Law Center of George Washington University in 1980.

January 1986

Statement of Alvin W. Trivelpiece
Director
Office of Energy Research
Department of Energy
FY 1987 Appropriations Hearings

Mr. Chairman and Members of the Subcommittee:

It is a pleasure to appear here today to present the FY 1987 budget request for the Magnetic Fusion Energy (MFE) program.

To assure our National long-term energy options, it is appropriate for the Federal government to sponsor R&D in those areas where the cost or duration of the program discourages private investment. The Magnetic Fusion program is a clear example of appropriate energy research for the Federal portfolio. The goal of this program is to establish the scientific and technological base required for fusion energy. The program is making excellent technical progress toward this goal. The long-term need and desirability for fusion energy continues to be strong. However, the program plan and the program budgets have been adjusted to reflect improvements in our near-term energy supply as well as the need to control Federal spending. During the mid-1970's the Magnetic Fusion Energy program responded to the then looming energy crisis, by laying out a plan that was dedicated to the goal of having a fusion energy reactor by the year 2000. A set of program activities was developed and a pace established to meet this goal. However, due to a relaxation in the energy crisis situation, there is now less urgency to develop an energy supply system based on the nuclear fusion principle. The desirability for such a system, however, remains strong.

Therefore, a revised Magnetic Fusion Program Plan was developed and put into place last year. This plan took into consideration the present economic conditions, the current energy situation and how it might change in the future, technical progress in fusion research, the ability to train scientists and engineers, the contributions to basic research in the fields of plasma physics and atomic physics and technology transfer. This plan has been accepted by both the Congress and the technical community.

The development of magnetic fusion could lead to economic energy sources that possess a secure fuel reserve, as well as acceptable environmental and safety features. The fuel, deuterium (and tritium from lithium), is readily available at low cost, and its supply is essentially unlimited. Potential end use applications are electricity generation, the production of synthetic fuels, nuclear fuels, and high grade heat for industrial applications.

The schedule for completion of magnetic fusion development is directly related to the present technical, economic, and political uncertainties of energy supply. Knowledge of how to employ fusion power, its economic costs and its environmental effects should be available when major decisions must be made on the deployment of new energy systems. It follows that, based on the estimated timescales for the resolution of uncertainties affecting the acceptability of other energy sources, the scientific and technological base for fusion should be available essentially by the turn of the century.

Fusion has a unique role in the process of determining our Nation's energy future. In principle, fusion energy has the flexibility to fit a variety of future energy scenarios. Fusion may provide improvements to the attractiveness of other energy sources as well as providing an attractive alternative to these sources.

Although magnetic fusion research and development is addressing a wide range of detailed scientific and technological problems, the remaining work that must be accomplished to reach the program goal can be summarized by defining four key issues.

The first of these issues concerns magnetic confinement systems. The particular type of magnetic geometry used can have a profound influence on the economics of a fusion device. Although significant progress continues to be made, it is not possible to design a fusion reactor at this time. Therefore, several potentially attractive confinement systems are being investigated. While many of these have similar features, it is likely that the most desirable system will include features from several different confinement systems. In addition, history has shown that progress in all systems will be more rapid because of the cross-fertilization possible between related concepts.

The second key technical issue concerns the properties of burning plasmas. Understanding the properties of burning plasmas is required to complete the scientific base. Furthermore, since a burning plasma will require much of the technology required for a

fusion reactor, it offers the additional benefit of advancing the technological position of the program goal.

The third key issue concerns materials for fusion systems. Since materials play a central role in determining the environmental characteristics of a fusion reactor, they are the key to realizing the benefits of fusion. Achievement of the program goal requires the development of new materials to enhance the economic and environmental potential of fusion.

The fourth key issue concerns nuclear technology of fusion systems. This issue requires advances in the basic engineering sciences, as well as the application of the results of basic fusion materials research. This issue will be completed only when integrated blankets are tested in a nuclear environment.

Our present strategy for addressing these issues is to take a complementary approach, which emphasizes development of the scientific and technological components or subsystems of the integrated fusion system, to the maximum extent that is technically feasible.

This approach is most appropriate for our program goal in the present circumstances. It allows accommodation of budget stringency, as well as for progress to resolve the technical uncertainties that exist about the exact nature of a suitable fusion reactor. There appears to be no premium on early deployment of fusion in our present energy circumstances. Therefore, time is available to perfect the fusion energy source, which we expect to be a critical necessity in the long run.

Finally, the utilization of the United States portion of the world's fusion development resources can be enhanced by this approach, since it provides the flexibility to collaborate internationally.

The essence of the program strategy is to maintain a broad domestic research and development program with emphasis on establishing the basic elements (components or subsystems) of the science and engineering technology required for fusion. Given the revised program goal, a great emphasis will be placed on creativity and innovation to enhance the economic and environmental attractiveness of fusion as an energy source, which will be assessed in comparison with other potential energy sources.

The focus on the practical energy goal of the program will be provided by fusion system studies. Technology transfer will be pursued by seeking industrial and utility participation in these system studies, as well as in appropriate research and development activities. To make best use of United States scientific strength in the area of fusion plasma research, a number of magnetic confinement systems, which offer promise of superior reactor performance, will be investigated. However, recognizing constraints on available resources, this investigation will emphasize increasing scientific understanding of the unique features of the most promising concepts, rather than attempting to develop each as a separate reactor system. To achieve a complete scientific base, we will address the scientific issues of fusion in depth through the generation and

study of high temperature plasmas in facilities of appropriate size and scope, including a burning plasma experiment. In the latter experiment, the lowest cost magnetic confinement system that can meet the scientific objective will be sought. This approach is intended to provide the broadest understanding at minimum cost and is most appropriate for the present stage of fusion development.

Over the last decade, a significant investment in equipment and facilities has been made and a core group of skilled scientists and engineers has been trained. With this investment in place, excellent and sustained progress is being made. We have reached a point now where there is general agreement that the remaining technical problems can be solved. The new generation of tokamaks has produced temperatures of one hundred million degrees and average energy confinement times of nine-tenths of a second. The experimental campaign to achieve energy breakeven conditions has just begun in the Tokamak Fusion Test Reactor (TFTR) at Princeton University. It appears that 1986 will mark the achievement of a goal sought for nearly 40 years. The general scientific progress of the last decade has also advanced the performance and future prospect of several other magnetic confinement systems. Several toroidal systems have achieved a state of scientific maturity such that they appear capable of exceeding the power density necessary to be a competitive economic power system.

On the technology side, a reactor-scale tritium fueling system is operating at Los Alamos National Laboratory. The International Large Coil Project at Oak Ridge National Laboratory is beginning

operation to demonstrate reactor-scale superconducting magnets. Radio-frequency heating modules at reactor power levels and pellet fueling systems have been developed and applied to our largest experiments. The feasibility of materials which are long lived in a fusion environment has been established for two classes of alloys. Initial work on the development of second generation low activation materials shows good promise.

While unresolved scientific and technological problems remain, the key achievements that were targeted by the program in the planning of the mid-1970's have or are being realized. However, it is almost axiomatic that achievement of the technical goals of a ten-year program plan requires the revision of future program goals to fit new externalities.

FY 1987 BUDGET REQUEST

The FY 1987 budget request for Magnetic Fusion Energy is $333.0 million. The request includes $307.5 million for Operating Expenses, $17.3 million for Capital Equipment, and $8.2 million for Construction (Table 1).

Given this current technical status and the revised program strategy, the FY 1987 budget request was developed with two major factors in mind. The first is a need to maintain a balance between our domestic science and technology program and those abroad, in order to allow effective international collaboration to supplement our domestic activities. The second is the need to support those experimental investigations that are appropriate in order to maintain progress. Facilities that are large enough to

Table 1
Magnetic Fusion Energy
Budget Authority
($ in millions)

	FY 1985	FY 1986		FY 1987
	Conf. Approp.	Conf. Approp.	Adjusted	Request
Operating Expenses	$369.6	$337.3	$324.5	$307.5
Capital Equipment	27.5	29.4	28.3	17.3
Construction	32.5	13.1	12.7	8.2
Total	$429.6	$379.8	$365.5	$333.0

explore high temperature regimes of plasma physics are required, as well as a number of smaller facilities for investigating key problems or scientific issues that can be addressed at more modest plasma temperatures.

The FY 1987 budget request has been developed to take advantage of the technical position that already has been established in fusion research. It will allow a continuation of cost effective progress toward the development of fusion power as a future energy option and positions the program to support the President's Geneva initiative on international cooperation in this area.

The request of $333.0 million represents the level of resources required to maintain an effective program. In order to maintain progress at this level of funding, the program has been narrowed to pursue only toroidal confinement systems. In addition, we have identified the highest priority tasks, improved the cost effectiveness of facility operations, and increased the use of international collaboration. The program has been focused to address the four remaining key technical issues--namely, the development of magnetic confinement systems, understanding of scientific principles of a burning plasma, the development of materials for fusion applications, and the development of fusion nuclear technology.

The FY 1987 budget request of $333.0 million will maintain some effort in each of the four key technical issues. At this level the FY 1986 initiatives needed to implement the revised program

plan continue while other program elements are delayed or deferred. In the Applied Plasma Physics subprogram, a core base of research is maintained. The two major device fabrication projects that were initiated in FY 1986, the reversed field pinch experiment and a compact toroid experiment will be continued. In the Confinement Systems subprogram, TFTR will attempt to reach breakeven conditions in deuterium plasmas and preparations will continue for limited D-T operation in 1989. As part of the US/Japan cooperation program, Doublet III will explore beta limits with shaped plasmas. Collaboration abroad, especially on European tokamaks, will continue. Collaboration on these tokamaks allows the U.S. to gain valuable information while avoiding duplication. Studies to support expanded collaboration with the Soviets will begin. In the advanced toroidal area, the PBX at PPPL and the ATF at ORNL will begin operation. In the tandem mirror area, the TMX-U and TARA experimental programs will be completed. The MFTF-B will be mothballed. In the Development and Technology subprogram, design studies on an experiment to study the physics of ignition will be continued. Facility design and development of ion cyclotron radio-frequency heating components will be emphasized. The six coil test in the International Fusion Superconducting Magnet Test Facility at Oak Ridge National Laboratory will be completed. The ongoing materials program will be m intained at a minimum level to support international collaboration in this area, and small-scale laboratory tests of critical blanket issues will be carried out.

The budget request for FY 1987 reflects a significant shift in the program balance. The near-term scientific and technological output of the program will be emphasized while continuing to pursue the long-range goal of developing fusion at a pace consistent with our national energy needs. The near-term program achievements also will continue to include the production of well trained scientists and engineers and contribution of advanced technology developments for industrial and defense applications.

The Magnetic Fusion Energy budget is organized into five interrelated functional areas that form the basis of a unified and balanced effort to conduct the research and development necessary to define a practical fusion product. The Confinement Systems and the Applied Plasma Physics subprograms, working in conjunction, provide the physics base for the Magnetic Fusion Energy program. In the near-term, the achievement of plasmas with the characteristics required to produce fusion energy flow from the experiments conducted in the Confinement Systems subprogram, with its focus on toroidal confinement systems.

The Applied Plasma Physics (APP) subprogram develops plasma physics theories and models to predict and explain the experimental and theoretical investigations of basic physics problems related to confinement concepts and develops diagnostic instruments for use by the Confinement Systems subprogram.

Using information developed by these two subprograms, the Development and Technology subprogram develops components and systems for use in near- and mid-term fusion experiments, and

long-term generic materials. This subprogram also performs conceptual design studies for fusion power reactor concepts and next generation devices. These design studies identify component and system development needs that must be undertaken to prepare for the eventual application of fusion.

In carrying out the assignments of the physics and technology tasks, needs for major new facilities are identified from time to time. The Planning and Projects subprogram provides for construction of major new facilities and fabrication of auxiliary components for these facilities. Finally, the Program Direction subprogram includes the funding to cover salaries, benefits, travel, and associated expenses of the Headquarters Office of Fusion Energy and associated support staff. The proposed budget levels for these areas are indicated in Table 2.

I would like to highlight some of the significant provisions of the FY 1987 budget request. In toroidal confinement systems, funds are provided to support the experimental operations of the Tokamak Fusion Test Reactor (TFTR) and the Princeton Beta Experiment (PBX) at the Princeton Plasma Physics Laboratory; the Doublet III-D (D-IIID) at General Atomic Technologies, Inc.; and the Advanced Toroidal Facility (ATF) at the Oak Ridge National Laboratory. The TFTR device will attempt to reach breakeven conditions and continue preparation for limited D-T operations in 1989. Doublet III-D, operating with a new vacuum vessel, will explore beta limits with shaped plasmas as part of the U.S./Japan cooperative program. In addition, procurement of long pulse ion sources for the device will be completed. Fabrication of the ATF

Table 2
Magnetic Fusion Energy
Budget Authority
($ in millions)

	FY 1985 Conf. Approp.	FY 1986 Conf. Approp.	FY 1986 Adjusted	FY 1987 Request
Operating Expenses				
Confinement Systems				
Toroidal Confinement Systems	$151.4	$147.1	$141.5	$151.8
Mirror Confinement Systems	55.0	49.0	47.1	25.7
Applied Plasma Physics	78.9	72.4	69.7	70.7
Development and Technology	67.9	59.3	57.1	50.5
Planning and Projects	12.2	5.7	5.5	4.8
Program Direction	4.2	3.8	3.6	4.0
Subtotal	$369.6	$337.3	$324.5	$307.5
Capital Equipment	27.5	29.4	28.3	17.3
Construction				
Fusion Materials Irradiation Test Facility	3.0	0	0	0
Mirror Fusion Test Facility-B	20.1	4.0	3.9	0
General Plant Projects	9.4	9.1	8.8	8.2
Subtotal	32.5	13.1	12.7	8.2
Total	$429.6	$379.8	$365.5	$333.0

and PBX-Upgrade will be completed and operations will begin to investigate advanced toroidal ideas. The Alcator C at the Massachusetts Institute of Technology and Princeton Large Torus experiments will be completed and the devices shut down. Collaboration abroad, especially on European Tokamaks, will continue.

Studies to expand collaboration with the Soviets will begin in order to position the program to support the President's Geneva initiative on international cooperation in fusion.

In the Mirror Confinement System program, the Tandem Mirror Experiment (TMX-U) at Lawrence Livermore Laboratory, TARA at Massachusetts Institute of Technology, and Phaedrus at the University of Wisconsin will be completed and the devices will be shut down. The MFTF-B facility at LLNL will be put in standby condition after completion of the construction project in FY 1986. This decision was made recognizing that increased fiscal stringencies would not allow us to continue support of all experimental devices. Since the toroidal configuration is the most developed of all concepts, we have chosen to focus the experimental physics effort around the toroidal concept.

In the Development and Technology area, program effort will be focused on the most critical technology issues. Experiments on the International Superconducting Magnet Test Facility at the Oak Ridge National Laboratory will be completed. Design of ion cyclotron radiofrequency heating components is to be emphasized. Nuclear technology effort will include nuclear analysis methods,

blankets, and tritium processing and control systems. In the materials program, effort on plasma materials and interactions and reduced activation and fundamental studies on neutron effects on alloys will continue with transition from the Oak Ridge Reactor to the High Flux Isotope Reactor. Design of an ignited, burning plasma experiment will continue.

In Planning and Projects, funds are provided to support the program's landlord reponsibilities at ORNL for GPP, GPE, and inventories, as well as the legislated requirements for the Small Business Innovation Research program.

The budget request for Program Direction provides for personnel and other costs associated with continuation of 62 full-time equivalents.

Mr. Chairman, that completes my prepared statement. I would be happy to answer your questions.

ALVIN W. TRIVELPIECE

Dr. Alvin W. Trivelpiece was nominated by the President on July 8, 1981, and confirmed by the Senate on July 27, 1981, as Director of the Office of Energy Research, U.S. Department of Energy (DOE). In this position, Dr. Trivelpiece serves as technical adviser to the Secretary on the Department's energy research and development programs and is responsible for the multipurpose laboratories and energy education and training activities. In addition, he manages DOE's programs for basic energy research, health and environmental research, high energy and nuclear physics, and magnetic fusion.

Dr. Trivelpiece has extensive experience in the areas of plasma physics and fusion research. From 1978 until assuming his current position, Dr. Trivelpiece was Corporate Vice President of Science Applications, Inc., of La Jolla, California, primarily responsible for internal research programs relative to innovative technical developments. From 1976 to 1978, he was Vice President for Engineering and Research at Maxwell Laboratories, San Diego, California.

During the period 1973 to 1975, Dr. Trivelpiece served with the U.S. Atomic Energy Commission as Assistant Director for Research in the Division of Controlled Thermonuclear Research. Prior to joining the Federal Government, he was Professor of Physics at the University of Maryland, serving in that capacity from 1966 to 1976. From 1959 to 1966, he was a professor at the University of California at Berkeley in the Department of Electrical Engineering.

He received a B.S. degree from California Polytechnic State University in 1953, an M.S. degree in 1955, and a Ph.D. degree in 1958. Both advanced degrees were awarded by the California Institute of Technology.

The recipient of several honors and awards, Dr. Trivelpiece is listed in American Men and Women of Science, Who's Who in America, and Who's Who in the World. He holds several patents in the area of physics research and is the author and coauthor of over 100 technical reports and books. Dr. Trivelpiece is a member of numerous professional organizations and is a Fellow of the American Physical Society, the Institute of Electronics and Electrical Engineers, and the American Association for the Advancement of Science. He has served as a consultant to various private associations and Government agencies and has lectured at conferences and universities throughout the United States and abroad.

Dr. Trivelpiece was born in Stockton, California. He is married and has three children.

June 1983

STATEMENT OF

MARY L. WALKER

ASSISTANT SECRETARY FOR

ENVIRONMENT, SAFETY AND HEALTH

FY 1987 APPROPRIATIONS HEARINGS

Mr. Chairman and Members of the Subcommittee, I am pleased to be here today to discuss with you the Department's budget request for FY 1987 for the Environment, Safety and Health Program. I am accompanied by Raymond Berube, Deputy Director, Office of Environmental Audit and Compliance, and Geoffrey Judge, Acting Director, Office of Budget and Administration.

NATIONAL ENERGY POLICY PLAN AND SAFE, ENVIRONMENTALLY SOUND OPERATION OF DOE ACTIVITIES

The overall goal of our national energy policy is to foster an adequate supply of energy at reasonable costs. The two strategies to achieve this goal are (1) to promote a balanced and mixed energy resource system and (2) to minimize federal control and involvement in energy markets while maintaining public health and safety and environmental quality. In addition, the Department is responsible for the manufacturing of nuclear weapons for national defense purposes. It is the stated policy of the Secretary of Energy to conduct all of the Department's operations in an environmentally safe and sound manner. Protection of the environment and the public are of paramount concern and importance to the Secretary and the Department.

GOAL OF OFFICE OF ENVIRONMENT, SAFETY AND HEALTH

The goal of the Environment, Safety and Health (ES&H) Program is to:

- o assure conformance of the Department's activities with all applicable environmental laws and regulations and assure that the health and safety of workers and the public are protected;
- o assure that national environmental protection goals are incorporated into the formulation and implementation of energy policy and programs;

- o assure that environmental, safety and quality assurance concerns are identified, prioritized and addressed through corrective and remedial actions, and areas of environmental and safety risk are reduced to levels as low as practical;

- o develop policy options for the Department on the effects of National environmental policy and regulations on U.S. energy industries and energy supply and demand; and

- o provide liaison with other federal agencies, such as EPA, concerning regulatory efforts and specific actions of those agencies that may have an impact on DOE operations.

PRINCIPAL STATUTORY AUTHORITY

As its principal basis in law, the Environment, Safety and Health program responds directly to 19 statutory requirements which are listed and briefly summarized in our FY 1987 budget submission.

ENVIRONMENT, SAFETY AND HEALTH RECORD

Among the primary objectives of the ES&H program are the assurance of the safety and health of the public and the quality of the environment, the protection of Government properties against accidental loss and damage, and the assurance of safe and healthful work places and conditions of employment for both DOE and contractor employees at approximately 225 industrial and research sites across the United States involving both nuclear and non-nuclear operations.

The vital interest that the Department places on its safety and health program, and the positive results realized from that program are best

illustrated by comparisons with the private sector. The following is a comparison summary of our FY 1985 safety and health record:

- o DOE's fatality rate of 1.2 deaths per 100,000 worker-years is approximately 10 percent of the private sector 1980-1984 average fatality rate reported by the National Safety Council.
- o DOE's recordable injury/illness rate of 2.2 cases per 200,000 work-hours is 33 percent of the private sector average rate for 1980-1984.
- o DOE's property loss rate of 0.44 cents per $100 property valuation is about 17 percent of the private sector experience rate.
- o DOE's vehicle accident rate of 4.0 accidents per million vehicle miles is about 21 percent of the National Safety Council's five-year statistical average for 1980-84.

Without exception, for each year since its creation, the Department has carried out its operational missions with a safety and health record that is at least two-to-three times better with respect to fatalities, injuries, and illnesses, and more than ten times better with respect to property protection, than that of the private sector.

The increasingly complex and dynamic situation regarding environmental laws and regulations has required us to reevaluate our environmental programs. Some of our facilities have been in use for nearly 40 years and many of the environmental problems we are finding at DOE facilities represent a "legacy of the past," from activities conducted in a different atmosphere and under different standards than are applied for today's more sophisticated and

highly publicized environmental and safety criteria. What was acceptable in 1945 is not acceptable in 1986.

NEW INITIATIVES IN ENVIRONMENT, SAFETY AND HEALTH

On September 18, 1985, Secretary Herrington announced a series of initiatives to strengthen the environment, safety and health function within the Department of Energy. These new initiatives are the result of a thorough review of the Department's environment, safety and health function by ES&H and senior management of the Department.

- First, oversight responsibility for the environment, safety and health function in the Department has been consolidated and upgraded under the new Assistant Secretary for Environment, Safety and Health. ES&H is now integrally involved in the operation of the Department at all levels, is directly overseeing the environmental and safety aspects of the Department's ongoing operations and necessary corrective actions, and is more integrally involved in decisions affecting those operations.

- Second, ES&H will conduct a baseline Environmental Survey of all DOE facilities to identify Department-wide existing environmental problems and areas of potential risk and to prioritize corrective action. The onsite Survey activities scheduled to begin in FY 1986 will take about 3 years to complete and will enable the Department to develop long-range planning for correcting environmental problems and reducing potential risks.

- Third, ES&H will conduct Technical Safety Appraisals of DOE's nuclear facilities to determine compliance with safety requirements, industry lessons learned, and licensed facility requirements. These will be on-

site technical appraisals of all aspects of safety, including nuclear reactor safety, nuclear process facility safety, health physics, training, emergency preparedness, occupational medicine, occupational safety, fire protection safety, and transportation and packaging safety. The Technical Safety Appraisals, begun in February 1986, will also be completed in about 3 years.

Other elements of the Department's strengthened Environment, Safety and Health program include regular field reporting and a Computer Assisted Tracking System, a more aggressive ES&H role in the development and implementation of environmental and safety policies for the Department, including more detailed Resource Conservation and Recovery Act and Comprehensive Environmental Response, Compensation, and Liability Act (RCRA/CERCLA) policy guidance, enhanced liaison with State and Federal agencies, and coordination of Departmental environmental activities such as compliance with RCRA and CERCLA requirements.

The new initiatives represent the Secretary's personal commitment to a quality environment and to the safety and health of our workers and all Americans. These initiatives assure that the Department has solid information upon which to base its clean-up and corrective actions, and strong oversight to ensure continued safe and environmentally sound operations.

I would like to emphasize that none of the new ES&H initiatives described above are meant in any way to suggest that line management in the Department has a decreased responsibility for safety and environmental matters. Line management has the basic responsibility to conduct its activities in accordance with the Secretary's environment, safety, health and quality assurance policies. The fact that ES&H is being strengthened does not alter this. Rather, these changes will provide line management with greater

technical assistance, more consistent policy, and the Department with more credible oversight and validated success in these areas.

PROGRAM ORGANIZATION

The new Environment, Safety and Health Program consists of six major units: Nuclear Safety, Operational Safety, Quality Assurance, Environmental Audit and Compliance, Environmental Guidance, and Environmental Analysis. Their activities include: the development of policies and standards; oversight, including the Environmental Survey, Technical Safety Appraisals and functional appraisals to monitor program and field performance in complying with DOE safety policies and standards, and in achieving effective safety and quality performance; technical assistance as needed to foster compliance; maintenance of the resources to respond to radiological emergencies; the review of NEPA documents; and the analysis of energy/environmental issues pertaining to the energy supply industry and to energy use arising from environmental legislative and regulatory activities.

FY 1986 PROGRAM PLANS

During FY 1986, we are focusing our activities on implementing the Secretary's new initiatives and upgrading our base program from within existing Departmental resources. The FY 1986 plans for the Environment, Safety and Health program include actions to:

- Implement the Environmental Survey by completing all necessary planning and preparatory activities and initiating the Environmental Survey for the first group of 5 sites.

- Begin the in-depth Technical Safety Appraisals of the safety of operations at Category A reactors (20 megawatts thermal or greater), high hazard nuclear facilities, and selected moderate hazard nuclear facilities to be completed on a three-year cycle.

- Issue revised DOE Safety and Quality Assurance Orders, and review and revise, as appropriate, DOE Environmental Orders.

- Review reactor safety analysis reports and nuclear facility safety analysis reports. These are in-depth multidisciplinary reviews to assure that an adequate degree of protection of the safety, health, and environment has been designed into reactors, high hazard nuclear facilities, and selected moderate hazard nuclear facilities.

- Implement additional modules on the Safety Performance Measurement System for environmental, safety reporting, radiation exposure data, and standards information, and a personnel and resources directory.

- Development of the Nuclear Criticality Safety Information System will continue with the system being expanded to a nuclear safety database which will include human factors and other nuclear safety data.

- Conduct technical evaluations of aviation operating procedures including eight appraisals of DOE aviation operating contractors.

- Develop guidelines on concept and content of a DOE Quality Improvement Program and Operation Readiness Reviews, and on the application and implementation of quality assurance principles and requirements to DOE computer program software and research and development programs.

- Develop environmental standards and provide environmental guidance and compliance assistance to the programs and field offices, and provide oversight of DOE programs, projects, and operations subject to environmental requirements.

- Implement DOE's regulatory review and coordination system to systematically identify, track, analyze, and prepare responses on external environmental, safety and health regulatory activities potentially affecting DOE activities and operations. Significant activities are anticipated with respect to the RCRA and CERCLA Acts.

- Continue to participate in analyses and research related to regional and global environmental issues such as acid rain, climate change, deforestation, and nuclear winter as well as analysis of regulatory and legislative proposals affecting energy elements. Much of this work involves participation in interagency and international meetings.

FY 1987 FUNDING

The FY 1987 budget request for the Environment, Safety and Health Program, is $76.1 million, an increase of $29.2 million above the adjusted appropriation for FY 1986 as noted in the following table. The increase is principally for beginning work on the Environmental Survey. The Environmental Survey is supplementary to the base program for environment, safety and health, and to ongoing environmental projects and corrective actions. Thus, funding for the Environmental Survey will not displace these other efforts.

FUNDING SUMMARY

(Budget Authority in Millions)

Environment, Safety and Health	FY 1986 Adjusted Appropriation	FY 1987 Request	Change
Environmental Audit and Compliance	$ 7.5	$ 34.0	$ +26.5
Nuclear Safety	16.9	17.2	+ 0.3
Operational Safety, Quality Assurance, and Environmental Guidance & Analysis	11.4	11.3	- 0.1
Program Direction	9.7	11.5	+ 1.8
Capital Equipment	1.4	2.1	+ 0.7
Total ES&H	$ 46.9	$ 76.1	$+29.2
Staffing (FTE's)	125 a/	127 a/	+2

a/Excludes 3 FTE's budget under the Nuclear Waste Fund.

FY 1987 PROGRAM PLANS

Environmental Audit and Compliance. This new office has the responsibility for conducting the Environmental Survey, for coordinating the Department's environmental issues review, and for field liaison on compliance issues and agreements. The FY 1987 budget request is $34.0 million, an increase of $26.5 million. During FY 1987, we will conduct the survey of approximately 20 DOE sites, and continue to coordinate Departmental environmental activities such as compliance with RCRA and CERCLA requirements.

Nuclear Safety, $17.2 million, has been increased 2 percent over FY 1986, with significant activity occurring on the new Secretarial initiative, the Technical Safety Appraisals. During 1987, we will perform extensive safety reviews of DOE facilities, including twenty-three Technical Safety Appraisals of Category A reactors and high hazard nonreactor nuclear facilities.

Emphasis will also be placed on the review and concurrence of reactor and nonreactor nuclear facility safety analysis reports covering new facilities or modifications and upgrading of existing facilities. The program will also maintain a viable radiological emergency response capability for DOE facilities utilizing the Atmospheric Response Advisory Capability and the Aerial Measurement System. Emergency response support will be made available to the DOD, and in coordination with the Federal Emergency Management Agency, on request to other federal and state authorities.

The budget request for Operational Safety, Quality Assurance, and Environmental Guidance and Analysis is $11.3 million which is essentially the same amount in FY 1987 as appropriated in FY 1986. Emphasis will be placed on issuing revised environmental protection, safety and health protection policy guidance for Departmental projects and operations, including comprehensive direction on hazardous waste (RCRA/CERCLA) requirements. This includes an aggressive role in developing and coordinating comments on new and revised environmental statutes, rules and policies of other agencies potentially impacting DOE and assuring clear, adequate guidance to our field operations. The base activities of appraising operational safety of the DOE facilities, assisting DOE program and field organizations in their development and implementation of the Quality Improvement Program concept, independently reviewing NEPA and other supporting environmental documents to assure adequate compliance, and participating in Departmental environmental analysis and research including acid rain issues will continue.

The budget request for Program Direction, $11.5 million, represents an 18 percent increase in FY 1987 over FY 1986 to support the increased staff necessary to implement the new Secretarial initiatives of the Environmental Survey and the Technical Safety Appraisals, and associated increased travel and contractual support.

The budget request for Capital Equipment, $2.1 million, is $0.7 million greater in FY 1987 than FY 1986. The increase is principally required to establish and operate the Computer Assisted Tracking System for environmental and safety data to monitor compliance and progress in completion of corrective actions at DOE facilities, and to assist ES&H in the early identification and correction of adverse safety trends and in reducing areas of environmental and safety risk.

SUMMARY

In summary, Mr. Chairman, the Secretary's new initiatives in environment, safety and health underscore the Department's commitment to protecting the environment and giving high priority to public and worker health and safety in our operations. Our FY 1987 budget request will enable us to accomplish our environment, safety and health goals in a responsible manner.

U.S. Department of Energy
Assistant Secretary for
Congressional, Intergovernmental
and Public Affairs
Office of Public Affairs
Washington, D.C. 20585
202 252 5644

BIOGRAPHY

MARY L. WALKER

Mary L. Walker was nominated by the President for the position of Assistant Secretary for Environment, Safety and Health, U. S. Department of Energy (DOE), on September 23, 1985, and confirmed by the Senate in December 1985. In this position, she manages the Department's environmental and safety guidance, compliance and oversight functions. Her responsibilities include oversight of over 260 nuclear facilities and 160 non-nuclear facilities. She also develops the Department's environmental and safety policies and standards and assists the Department's field operations and programs in the areas of new project review, liaison with states and federal agencies, technical expertise and compliance.

From June until December, 1985, Ms. Walker was a special consultant to the Secretary of Energy. Previously, she served as the Deputy Solicitor for the Department of the Interior under William Clark. In this role, she supervised 220 attorneys including eight Regional offices, and provided legal counsel to the Secretary and program heads on the many varied legal issues involving that Department.

In 1982 she was recruited by the Reagan Administration as the chief Deputy Assistant Attorney General in the Land and Natural Resources Division, U.S. Department of Justice. She supervised a staff of 155 persons and managed the federal government's environmental litigation, involving over 2,500 cases relating to the federal government's protection and regulation of land and natural resources.

Ms. Walker was a partner with the Los Angeles law firm of Richards, Watson, Dreyfuss & Gershon, practicing in the areas of land use and environmental law and litigation from 1976-1982. In addition to representing individual and corporate clients, Ms. Walker represented various public entities, including approximately twelve Southern California cities. She handled matters involving federal and state agencies, and is experienced in both federal and state court litigation.

From 1973-1976, Ms. Walker was an attorney with Southern Pacific Transportation Company in San Francisco. She represented Southern Pacific and its diverse subsidiaries, including railroad, pipeline, trucking and land companies, in the then-emerging area of environmental law.

Ms. Walker received her B.A. in biological sciences/ecology from the University of California at Berkeley in 1970. She attended U.C.L.A. Law School and Boston University Law School, receiving her J.D. in 1973.

February 1986

Statement of Donald L. Bauer
Acting Assistant Secretary for Fossil Energy
Department of Energy

FY 1987 Appropriations Hearing
- Statement for the Record -

Mr. Chairman and Members of the Committee:

As part of its FY 1987 budget proposal for Fossil Energy-related programs, the Department of Energy is requesting $1.2 million for the Liquefied Gaseous Fuels Spill Test Facility. The facility, now being readied for its initial tests, will serve as a "test bed" for both industry and government in developing safety and environmental control information on the potential hazards of liquefied gaseous fuels and other toxic liquids should they be accidentally released during commercial transport, manufacturing, or storage.

Construction of the estimated $7.9 million facility began in June 1984. Located on an isolated section of the Frenchman Flat Basin in the southeast corner of the Nevada Test Site, the facility was completed in December 1985 and is now undergoing a series of checkout tests to ensure that all equipment and instrumentation function properly.

The first test "window" -- a time when actual spills can be conducted as dictated by local weather patterns -- will open in April 1986 and extend through September 1986. This will allow two to three series of tests, each series consisting of four to five spill tests.

Commercial user fees will cover actual costs of the tests plus any clean-up necessary to prepare the facility for the next user.

FACILITY DESCRIPTION

The facility consists of a control building housing data acquisition and recording instruments, a command and control computer, and a tank farm and spill area. The tank farm includes the following: (1) A spherical shaped 8,000-gallon tank to house liquid nitrogen, (2) a nitrogen vaporizer to convert liquid nitrogen to a drive and control gas, (3) pressure vessels to store the nitrogen gas, (4) a 26,000-gallon tank to store noncryogenic fluids for spill tests, (5) two 28,000-gallon dewars for storage of cryogenic test fluids, and (6) two twelve-inch diameter insulated lines and one six-inch diameter insulated line, all extending 500 feet from the tank farm to a point where fluids will be spilled for testing.

When spill tests are conducted, gaseous nitrogen (obtained by vaporizing the liquid) will force the test fluids from their storage tanks through the spill lines. Spill rate and duration, as well as test condition parameter checks, will occur under computer control from the control building. Also, 700 channels of data originating from remotely located sensors will be recorded.

POTENTIAL USERS

The ultimate objective of the Liquefied Gaseous Fuels Spill Test Facility is to give both private and public sector users the technical data they need to better protect the public from the potential health and safety hazards posed by a spill of liquefied gaseous fuels or other toxic liquids. An aggressive effort, therefore, has been undertaken to apprise relevant sectors of the fuels, chemicals and transportation industries of the availability of this one-of-a-kind test facility. This effort has extended both to domestic and to international organizations that have an interest and need for safety related data on liquefied gaseous fuels or toxic chemicals.

Currently, test plans, agreements, and operational procedures are being negotiated between the Energy Department and the Gas Research Institute and the Department of Transportation. These tests, slated for calendar year 1986, will help evaluate the effectiveness of "vapor fences" in mitigating the accidential releases of liquefied natural gas at peak shaving plants. Specifically, the tests this year will assist in validating wind tunnel simulations of vapor fence effects on heavy gas dispersion. Once validated, the wind tunnel models will be used to determine the vapor fence performance for several different accident scenarios.

Also being negotiated are tests to be funded by Amoco Oil Corp. to obtain downwind concentration measurements for hydrogen fluoride gases. This will help verify atmospheric dispersion models. Phase I of the test series is scheduled for calendar year 1986 and will consist of 3 to 5 tests to examine downwind concentrations when hydrogen fluoride is released in a horizontal jet and when it evaporates from a pooled spill.

FY 1987 BUDGET PROPOSAL

The $1.2 million requested for Fiscal Year 1987 will provide a bridge from the current DOE check-out and facility verification program to one supported by industry and other government agencies. It will provide the fiscal flexibility to assure that the facility is available and ready for user-sponsored tests. A minimum number of key scientific personnel would be retained to assess proposed test plans, to aid in the conduct of tests, to collect data, and to analyze test results.

Also, funding will be used to organize activities required for facility check-out, start-up and operation, in order to establish credibility with potential customers.

Once demand for service is established, current plans call for the costs of the core research team and other services to be financed by user payments. Based on experience with current customers, we anticipate that by Fiscal Year 1988, users of the test facility will be paying for all facility-related expenses.

MONDAY, MARCH 10, 1986.

NUCLEAR ENERGY

WITNESSES

JAMES W. VAUGHAN, JR., ACTING ASSISTANT SECRETARY FOR NUCLEAR ENERGY

LYLE C. WILCOX, DEPUTY ASSISTANT SECRETARY FOR REACTOR SYSTEMS DEVELOPMENT AND TECHNOLOGY

WILLIAM R. VOIGT, JR., DIRECTOR, OFFICE OF REMEDIAL ACTION AND WASTE TECHNOLOGY

Mr. BEVILL. We will bring the committee to order. Mr. Vaughan, we are pleased to have you with us. You may proceed as you wish.

Mr. VAUGHAN. Thank you very much, Mr. Chairman. I am pleased to have the opportunity to summarize the Department's Nuclear Energy Research and Development and Remedial Action and Waste Technology programs.

I will provide a brief overview of all of our programs. I have prepared a detailed written statement which I would like to submit for the record.

OPENING STATEMENT—NUCLEAR FISSION

Mr. BEVILL. It will be made a part of the record. We will be glad to hear your summary.

Mr. VAUGHAN. I do have with me this afternoon Mr. Bill Voigt, to my left, who manages the remedial action programs, and Dr. Lyle Wilcox, to my right, who manages our advanced reactor development efforts.

Mr. BEVILL. We are glad to have both of you with us.

Mr. VAUGHAN. They will help me respond to your queries.

Mr. BEVILL. Any questions you can't answer they will answer for you; is that right?

Mr. VAUGHAN. There shouldn't be too many of those. We will just divide it up.

The Department places high priority on ensuring that nuclear energy continues to contribute to a strong, stable, and secure national energy base to meet both civilian and military requirements. Our commitment to nuclear energy remains firm. Our reactor development programs are an integral part of our commitment to help preserve the nuclear option.

The Department also remains strongly committed to protecting public health and safety and to assuring a safe and clean environment in connection with its activities. Our remedial action and waste technology efforts are an integral part of that commitment.

The funding levels for our various program elements are tabulated in my prepared statement, and I will not repeat them. While

the overall Fiscal Year 1987 budget request for Nuclear Energy Supply Research and Development programs increases slightly from our Fiscal Year 1986 estimate, there have been some shifts in relative funding levels for individual programs. Within an essentially level budget, our funding request for nuclear energy R&D has decreased by about $45 million compared to Fiscal Year 1986.

There are several key factors that influenced the formulation of our programs and budget request.

First, the Department is fully committed to support the bipartisan effort to control and reduce the Federal deficit. Although it may appear to some that worthwhile R&D elements have been eliminated or significantly reduced, we believe that each of our programs is focused to make optimum use of limited resources.

Second, space and defense nuclear energy needs are increasing as planned. Some of these activities have progressed from the design and screening phase into the more funding-intensive hardware phase. These activities are an essential part of a top national priority.

Third, our civilian reactor research and development program is more sharply focused. Last year, we testified to our conviction that the institutional and technical impediments to the near-term deployment of light water reactors must be overcome before there would be a good chance to realize the potential of more advanced reactors. Our Light Water Reactor R&D program is focused on essential research and development which can help facilitate efforts by U.S. industry to usher in a new, advanced generation of nuclear powerplants.

The time is ripe for the completion of development and certification of advanced, state-of-the-art LWR designs. Certainly, the currently anticipated timing for the commercial introduction of innovative reactor technologies, beyond light water reactors, has been stretched out. We have made excellent progress in our HTGR and LMR design work in the past two to three years. Our focus is now upon key features affecting the economic, passive safety, and technical issues of these concepts to preserve their potential for the future.

Fourth, the Remedial Action and Waste Technology budget request increases significantly compared to Fiscal Year 1986, but less than previously forecast. The program objectives can be achieved at this level of funding by extending the authorization period for the Department's Uranium Mill Tailings Remedial Action Program from March 1990 until the end of Fiscal Year 1993, consistent with the guidance provided last year by this subcommittee.

NUCLEAR ENERGY R&D

Against this background, let me turn to a few of the key issues and highlights of our Nuclear Energy R&D programs.

The Department has provided R&D support for both the defense and civilian nuclear energy areas for decades. Both areas will continue to be served by our proposed programs, which will be integrated and coordinated to the maximum extent practical so as to minimize overall cost. The priority of defense nuclear energy programs for military applications has not changed; those programs

related to SDI have expanded and moved ahead as planned while overall funding stringencies have tightened.

Therefore, in the face of the urgent need to reduce government outlays, the Department has recommended an adjustment in the pace of the Advanced Civilian Reactor Development Program—one which will still keep us ahead of market needs for the types of reactors involved.

Turning first to our effort on Light Water Reactors, I would note that the technical support for demonstrated removal of the remaining technical, licensing, and institutional impediments to the next generation of LWRs, as well as for innovative advanced reactors, is a key objective of our R&D programs. A key milestone in the pursuit of this objective will be to achieve NRC certification of at least two Advanced LWR systems in approximately five years.

Work on Advanced LWRs also includes R&D needed to bring forward a new generation of mid-sized LWRs. With today's pattern of lower load growth rates, plants with smaller than 1,000 MWe ratings and lower total capital cost may be required to meet utility needs. Both the market and the regulatory process are too uncertain to justify the sufficient private sector financial investment on their own to carry the design concepts to a stage at which their potential can be adequately assessed.

In Fiscal Year 1986 and Fiscal Year 1987, DOE—through competitive contracting and in cooperation with EPRI—will be providing selected technology support for these advanced designs through cost-shared programs.

As you know, with respect to our Advanced Reactor Research and Development Program, at the request of the Secretary, the Energy Research Advisory Board convened a Civilian Nuclear Power Panel in October 1985 to review and comment on the Office of Nuclear Energy's draft Strategic Plan for Civilian Reactor Development. The essence of the draft Strategic Plan is to establish an agenda of requisite actions and tasks to develop advanced reactor systems that can be acceptable and competitive in a future civilian market.

While the pace of the program to fulfill that agenda must be adjusted to accommodate national priorities and funding constraints, it is the Department's intent to continue to operate our unique liquid metal reactor test facilities and to conduct the R&D leading to the licensing and potential commercial deployment of advanced reactor systems at an appropriate time in the future. A revised Strategic Plan, based on consideration of comments received from the ERAB Panel, Congress, and others, will be valuable in guiding and focusing DOE's civilian reactor development programs, in helping assure complementary efforts by the private and public sectors, and in maintaining goals and objectives to ensure effective utilization of public funds. We plan to complete a revised plan this spring.

In the current fiscal year, work will continue on the development of LMR and HTGR designs and their supporting R&D activities. Fiscal Year 1987 will see a further focusing of our effort on key economic and safety aspects of these designs, to assure an assessment of the key technical knuckle points, if I can call them that, that affect the potential licensing of those reactors.

The advanced reactor program for Fiscal Year 1987 and beyond will build on the substantial progress made by advanced reactor technology and design R&D over the years. Passive safety features are being incorporated into the advanced reactor designs to reduce significantly the likelihood and consequences of plant failures. Key related activities will be the completion of transient tests in the FFTF and transient overpower tests in the EBR-II.

The safety systems design activity incorporates the integration of state-of-the-art technology in communications, controls, and operations into advanced reactor designs. The core demonstration experiment activities will continue the progress made towards the objective of extending core life to at least three years. The potential exists to achieve much longer core lifetimes with attendant economic benefits. The continued objective of the advanced metal fuels work is to establish technical feasibility to improve safety margins, fuel cycle costs, and potentially on-site reprocessing.

SPACE AND DEFENSE NUCLEAR ENERGY

I would like to turn now to our Space and Defense Nuclear Energy programs. As you know, this segment of our program is structured to respond to requirements identified by NASA and the Department of Defense, including the Strategic Defense Initiative Organization. These cost shared program activities will provide the design, development and supporting technology to build compact, high performance reactors for space and terrestrial applications and dynamic isotope power systems for space application.

The first phase of the joint DOE/NASA/DOD SP-100 program culminated with the selection of a concept for further engineering development and demonstration testing during the next phase, the Ground Engineering Test. The selected concept will be designed, built, and tested at a reference power of 300 kilowatts electric. Efforts to select a system design and integration contractor for this five-year effort are underway.

A key objective of the Multimegawatt Space Nuclear Power Program is to identify and develop at least one space nuclear power system concept by 1991 that alone, or in combination with a nonnuclear power system, meets SDI multimegawatt power requirements. The Fiscal Year 1987 effort will continue the evaluation and development of potential multimegawatt space reactor concepts. In addition, work will continue on development and testing of enabling technology that is required.

Turning now to the Small Nuclear Power Source Demonstration Project, nuclear reactor technology appears to offer alternatives to conventional power systems for such applications as the North Warning System, which is the upgrade of the Distant Early Warning line across northern Canada.

In Fiscal Year 1987, tests will be conducted to verify the performance of the reactor subsystem. The complete system will be installed in a test cell at the Atomic Energy of Canada's Whiteshell facility, and system startup tests will be initiated in early Fiscal Year 1988.

In response to interest by the Air Force—as well as SDIO—an effort is underway which will lead to the design of a nuclear power-

plant with a nominal 10 megawatt electric rating. This plant will feature a passively safe design, a capacity factor in excess of 90 percent, refueling intervals which could range from four to 10 years, and will be hardened against specified military threats. The SDIO has also expressed interest in a nuclear powerplant for its ground-based applications.

A Request for Proposals for advanced design of the plant has been prepared. In late Fiscal Year 1986 up to two concepts will be selected for detailed design; the preliminary design will be completed by the end of Fiscal Year 1987, or in early Fiscal Year 1988.

In our Advanced Nuclear Systems program we have the responsibility to develop, demonstrate, and deliver radioisotope power sources for U.S. military and civilian space and terrestrial missions. The RTGs, or Radioisotope Thermoelectric Generators, for Galileo and Ulysses, passed all tests and are ready for launch, which has been deferred to the summer of 1987. Additionally, NASA plans to continue to use RTGs on their next generation of planetary explorers—the Mariner Mark II planned for the 1990s.

In looking to future NASA and DOD space missions, DOE is continuing to pursue the technology and the development of an advanced RTG that offers promise of higher power density and greater size adaptability as mission requirements change.

MAJOR FACILITIES

With respect to DOE's major facilities, I would like to note that the accomplishments and activities of these facilities and test programs continue to be very significant. The Fast Flux Test Facility has achieved a world record—101 days—for continuous operation of an LMR at full power, demonstrating the outstanding reliability of LMRs. Fuel performance in the FFTF has gone well beyond the burnup goal of 80,000 megawatt days per metric ton. We have recently successfully completed a test in EBR-II where we accommodated a loss-of-flow, without reactor scram or other operator action, starting at 100 percent power. This test further attests to the passive safety potential of liquid metal cooled reactors. Testing at the Energy Technology Engineering Center is currently making significant contributions to LMR designs resulting from their natural circulation tests, advanced shutdown heat removal tests, and performance testing of advanced steam generators. Operation of the FFTF, EBR-II, and ETEC continues to contribute to U.S. and international liquid metal reactor operating experience which is essential both for potential converter reactors as well as long-term breeder applications.

Therefore, these facilities continue to provide unique testing capabilities required for the development of nuclear energy sources that will be suitable for civilian power generation, space, and military applications.

The Department does plan to evaluate the current methods by which users share in facility costs. Alternative cost-sharing approaches will be evaluated for partial implementation in Fiscal Year 1987, with full implementation planned for Fiscal Year 1988, if practical.

REMEDIAL ACTION AND WASTE TECHNOLOGY

Let me conclude by commenting briefly on our Remedial Action and Waste Technology program. My written statement contains detailed information on each of the projects underway in this program. Emphasis in all remedial action programs will concentrate on cleanup activities at highest priority sites and the continued protection of the public and the environment at all sites.

One program of particular interest to this subcommittee is the Uranium Mill Tailings Remedial Action Project, which is responsible for conducting remedial action at 24 former uranium ore processing sites and several thousand contaminated vicinity properties. The Act establishing this program provides authority for remedial action by the Department for a period of seven years following promulgation of standards by the Environmenmtal Protection Agency, which occurred in March 1983.

Our proposed 3 1/2-year extension of this project takes into consideration the actual project experience gained in performing remedial action at several procesisng sites and many vicinity properties. Project plans have been revised to reflect this experience and more level funding and work loading among the projects. Within these plans, work will continue first at the high priority sites with minimal planned extension in previous schedules for these sites.

Mr. Chairman, this completes my statement. We would be pleased to respond to any questions you may have at this time.

[The statement of Mr. Vaughan appears at the end of this hearing]

SHIFT TO DEFENSE NUCLEAR ACTIVITIES

Mr. BEVILL. Mr. Secretary, the civilian nuclear research program is now largely a defense nuclear reactor program, so I would ask you to tell us why this has occurred and what the long-term impact on the civilian research will be.

Mr. VAUGHAN. Mr. Chairman, I would think that perhaps a better characterization of the program, rather than describing it as largely defense-oriented, is to indicate that it is a most effective combination of reactor development programs to meet both the civilian and the military needs.

The programs have been paced consistent with the specific needs as we see them for both the military and the civilian marketplace, and so the timing is somewhat different. We have some significant cross cutting between technologies in the programs. If you please, I think we are trying to get more bang for the buck. The Energy Research part of DOE continues some longer range programs that will be relevant. The NRC continues some shorter range programs.

I frankly think that the impact on the civilian research and development efforts will be positive in the long term and the work that we continue to do, and plan to continue to do, will meet the pace of the market which has stretched out, as we all know.

STRATEGIC NATIONAL NUCLEAR PLAN

Mr. BEVILL. In light of this new direction, what has or will become of the strategic national nuclear plan?

Mr. VAUGHAN. Again with respect to new direction, when we couple in the key tests and efforts that are conducted at the facilities which I described in my opening remarks, I would say we still have approximately a 75 percent civilian program, 25 percent defense program. I have commented in my opening statement that the agenda in the strategic plan is still largely intact and that the pace will have to be shifted consistent with these same directions. The Energy Research Advisory Board Panel has not yet reported back to DOE, although many of the comments in their public meetings have been generally supportive, and we anticipate having a more integrated and revised plan later this spring.

FEDERAL INVOLVEMENT IN NUCLEAR RESEARCH

Mr. BEVILL. Many now have the view that the nuclear industry is mature and needs very little federal involvement from a research standpoint. Do you agree with that?

Mr. VAUGHAN. Mr. Chairman, I really don't fully agree with that. I think the pronouncements that the nuclear industry was fully mature were premature, if I can make a play on words there. The industry is going to be driven by things that they believe can bring an acceptable return on their investment, and it is clear to us that federal efforts to rationalize the safety features that have caused over regulation of many of these plants, and to focus on continuing technical advancements is essential to a renewal of the nuclear option. We have had some excellent response from industry and industry organizations such as EPRI on some of the work we have initiated helping to bring that to a focus.

DUPLICATION OF RESEARCH

Mr. BEVILL. On the defense area that you seem to be moving into, is this going to result in any duplication of research by the Defense Department and you?

Mr. VAUGHAN. Mr. Chairman, it is our intent that there not be any duplication of effort. The reactor development programs that are a part of that effort are being managed by the DOE, consistent with our historical role stemming all the way back to the Atomic Energy Commission to manage those programs, and the cost-sharing aspects of those result in the money from the Defense Department being utilized jointly by us on those programs, but the programs are not separately managed.

FEDERAL SUPPORT

Mr. BEVILL. For many years you have come before us and asked us, and we have supported you, on funding for reactor development activities, such as the gas-cooled reactors, the integral fast reactor, the breeder technology, and so forth. We have appropriated hundreds of millions of dollars that you have spent on these. What is going to become of these technologies without federal support?

Mr. VAUGHAN. The federal support is not going away, Mr. Chairman. As I commented in my statement, we are moving at a perhaps reduced pace, but these efforts are being consolidated to the best extent possible in our advanced reactor development pro-

grams. A number of the payoffs have been in the accomplishments of the tests which I cited in my opening statement. We could cite more of those for you if you would like.

There will be a significant focus in the next couple of years on the passive safety features of these reactors, which are key to their economics and licenseability, and a critical assessment, by us together with NRC and industry participants, of the licenseability of the concepts, which if it is not there, may not support some of the economic claims.

The other thing I would note is that a number of the potential defense-related reactors build on and utilize the concepts of the liquid metal technology, and even the gas-cooled reactor technology. For example, the basic fueling concept for the small North Warning System reactor that I described is gas-cooled reactor technology and fuel.

Mr. BEVILL. So as we say, the bottom line of your testimony is that these programs, like the gas-cooled and all, would all be consolidated with the others. They will be improved upon. They will be stretched out. Of course, stretched out means delayed, doesn't it?

Mr. VAUGHAN. Yes, I think that is a fair term.

Mr. BEVILL. The Chair recognizes Mr. Myers.

LIGHT WATER REACTORS

Mr. MYERS. Thank you, Mr. Chairman.

Mr. Vaughan, the light water reactor has been the work horse in the American nuclear industry for number of years. When was the last light water reactor sold in this country?

Mr. VAUGHAN. In the mid-'70s, early to mid-'70s.

Mr. MYERS. Are there any orders that you are aware of right now for a light water reactor?

Mr. VAUGHAN. No, there has been a hiatus on those orders, for a number of reasons, not so much for the reactor itself, but for the fact that the demand projections were overstated for many years, and due to the fact that we have gotten ourselves in a regulatory situation that needs to be rationalized. You are well aware we feel strongly that some legislative initiatives need to be put in place by this Congess to help that process, and we proposed legislation along those lines.

Most of the people in both the reactor supplier industry and in the utility industry recognize the demand is coming. The safety record of those reactors and their reliability record is in fact good. The technology is moving ahead overseas, particularly in Japan, where advanced light water reactor projects are underway with U.S. and Japanese industry.

We believe that we can build upon that for a reopening of that nuclear option in this country. Most people we talk to, including the advice we are receiving from our Energy Research Advisory Board, indicates that an extension of improved light water reactors is a necessary next and first step. Those can be deployed without prototypes, which are expensive to construct and demonstrate.

Mr. MYERS. Then you are blaming the lack of interest or lack of involvement with the light water reactor on the licensing process rather than the reactor itself?

Mr. VAUGHAN. I think that is a major factor, coupled with the decrease in demand projections. We have a kind of domino effect with a number of factors, all of which have extended construction times and increased costs.

Mr. MYERS. That is right. As we all know, it takes a long, long time to build any reactor or any generation today for that matter that would be conventionally steam powered, with fossil fuel. It takes a long time to get them licensed and on line. The demand isn't here but as it continues to recover it would appear that some of the utilities that are of concern are interested right now but I don't see many of them talking the light water reactor. I wonder why the $40 million for research this year. You mentioned other technologies also.

Mr. VAUGHAN. As I commented, Mr. Myers, I believe that the area of light water reactors will be the near-term rejuvenation. The major focus is rationalization of the licensing process with features such as advanced: certification of design, so that you have an approved design in hand before you proceed, the preselection of sites; a rationalization of the backfitting process; and a combined construction and operating permit so that if you proceed to place an order and you build it to spec, you can proceed to operate it. You can get those plants built in five or six years, just like you do overseas, and you aren't completely betting your store when you start to pour concrete.

STANDARDIZATION

Mr. MYERS. Mr. Vaughan, you know this committee was hearing that 10 years ago, the same words, almost identical, that we are just on the verge. We urged the Department of Energy, which was formerly of course the Atomic Energy Commission, to come forth with a prototype, and they weren't about to do that. The systems being built in this country were all pretty much along the same line, but it didn't stop action by environmental groups and by various citizens' groups, whatever name they travel under.

Most of the utilities that I have talked with are more concerned about a safe reactor, and frankly I don't hear many of them talking about the light water reactor. They want something that is so-called "inherently safe" as a reactor. There are some that propose to be that, and I wonder, if this be the case, if utilities are frightened or afraid to step out and order a light water reactor, why we are continuing all the research, if we shouldn't join what they want.

Back when I was in business in the real world, I never tried to force something on someone. I always tried to find out what the market wanted and then answered their demands of the day. Am I hearing the wrong signal here?

LIGHT WATER REACTORS

Mr. VAUGHAN. I think we are listening to what we hear. What we hear is that the industry and the utilities want improved light water reactors including the mid-size range, which they can add to their systems sooner than the more advanced designs, because those will not take prototype demonstrations.

Some of the advanced light water reactor designs that have been quietly proceeding ahead, as evidenced in technical reviews, probably have a factor of 10 improvement in their resistance to severe accidents compared to the light water reactor at the TMI–2, for example. So there has been some very quiet effective improvement that we need to deploy.

In the mid-size range, you can get more inherent safety built into the plant, perhaps not in light water reactors to the same degree that you could in liquid metal reactors, but certainly to a very sufficient degree.

Mr. MYERS. A utility that knows they are going to need power 10 years from now, if they came to you, what could you tell them as to any significant breakthroughs in the last year on light water reactor research? Are there any milestones that you can tell them, yes, there is going to be a reactor that you are going to need that is going to be available that is going to be inherently safe? What have we done in research in the last year?

Mr. VAUGHAN. First, the major things we are learning come out of our safety-related research program, as well as our program that is continuing to examine the facts and the residue from the TMI–2 incident that tell us in our severe accident technology there are much more rational bases for the regulatory requirements and for the emergency planning. There are improved shutdown features being incorporated in those designs. I think there has been some steady, quiet improvement going on.

I would remind you that a portion of that $41 million request is a continuation of our effort at Three Mile Island which we are committed to, which I think is going to bear good fruit in the long run.

Mr. MYERS. It seems like there is a retrenchment by the Department that, yes, we are going to shove light water down your throat whether you like it or not. Maybe I am wrong about that.

Mr. VAUGHAN. Absolutely not, Mr. Myers. It is not our intent to shove it down anybody's throat.

Mr. MYERS. Why the reduction?

Mr. VAUGHAN. This whole program is aimed at a market pull, not a DOE push. It is based on the interest we have gotten in the advanced light water reactor programs from the industry participants with whom we have initiated cost-sharing efforts, like the efforts going on by EPRI, I think there is a real near-term pull in that direction. That is a loud message we have been getting from our Energy Research Advisory Board Panel in their preliminary comments.

Mr. MYERS. Did you ever speak to the panel in advance?

Mr. VAUGHAN. I don't believe so, no.

Mr. MYERS. They do meet, they do do something?

Mr. VAUGHAN. Yes.

Mr. MYERS. Besides talking to themselves.

Mr. VAUGHAN. Yes, they do, and they will be providing a report to the Department.

Mr. MYERS. Is that the first report?

Mr. VAUGHAN. No, we do not have the first report from them. Their meetings are public, and so you listen to the conversation during the meetings. We expect to receive their report by May.

ADVANCED TECHNOLOGY RESEARCH

Mr. MYERS. Why, then, the reduction in the advanced reactor technology research?

Mr. VAUGHAN. I think basically, it's a matter of the best judgment of what we can do with the resources on the bottom line, and the pace needed to deploy these reactors. For example, if you take the high-temperature gas-cooled reactor which is advocated by many, its principal advantage is in the area of potential process heat applications.

I would like to see a number of those applications emerge in this country, but frankly, as we talk to people in the marketplace, that is not likely to occur until the turn of the century or later.

URANIUM ENRICHMENT

Mr. MYERS. On page 7 of your prepared remarks you say, "We were able to increase our share of the free world enrichment market from 43 percent in 1985 to 53 percent in 1990." That is contracts, I take it?

Mr. VAUGHAN. Yes.

Mr. MYERS. Does the buyer have to buy? Is it a higher purchase contract? How do you know it is going to be 53 percent in 1990?

Mr. VAUGHAN. That is our projected set of requirements. We are planning to be here with you on Thursday of this week to talk about uranium enrichment, and maybe it would be more appropriate to go into that subject at that hearing.

Mr. MYERS. I want some answers about AVLIS on that when you come in.

Mr. VAUGHAN. All right.

Mr. MYERS. Wednesday.

Mr. VAUGHAN. It is Wednesday, I apologize.

Mr. MYERS. I have some other questions for the record but thank you for your testimony.

Mr. BEVILL. The Chair recognizes Mrs. Boggs.

ADVANCED REACTOR RESEARCH

Mrs. BOGGS. Thank you, Mr. Chairman. Welcome, gentlemen.

Over the past decade, as the Chairman has said, we have invested a great deal of money in advanced reactor research. Could you summarize for us the practical progress that has been made in the various technologies?

Mr. VAUGHAN. Mrs. Boggs, if I could, I am going to ask Dr. Wilcox to respond to that question for you.

Dr. WILCOX. I think that we are at that point in time where we have focussed on some very important features of these emerging technologies. We have done a great deal of work in the area of fuels, especially oxide fuels. We understand these fuels and how they behave, and we are now taking all that background of research and testing and empirical data and focussing ourselves to prove that these fuels can be very long life, or long-term fuels, so that we might place them in a reactor and have no need to refuel that reactor for three, five, seven, or 10 years. This work is very promising and I think it is only the result of a great deal of work

on the technologies referred to. We are looking at metal fuels in comparison with oxide fuels and comparing the advantages and disadvantages of those two in terms of reprocessing and recycling.

The background at our test facilities, EBR-II, FFTF and ETEC, gives us the kind of focus that we have right now in talking of passively safe and efficient reactors that are economically viable.

TMI CORE SHIPMENT

Mrs. BOGGS. How do you plan to ship the Three Mile Island core out to the Idaho National Engineering Lab?

Mr. VAUGHAN. Mrs. Boggs, that fuel is going to be shipped in specially designed casks with a double containment seal that is required for that type of shipment by NRC regulations. Those casks have been fabricated, tested, and NRC certification of those casks is to be completed sometime this month, which will support the start of the shipping schedule in June of this year.

Mrs. BOGGS. What kind of transit safety precautions are to be taken and how will this be coordinated with the authorities on the route from Pennsylvania to Idaho?

Mr. VAUGHAN. The procedures that are to be followed are those that would be followed for any normal commercial expended fuel shipment. There will be advanced notification of all of the states and localities along the route. We have already done some pretrial runs of that, and I would remind you that from a radiological hazard point of view, the expended fuel from the TMI-2 is more benign than the fuel that you take out of the average commercial core, because it only operated for a few months, and has now sat there and decayed for over five years. We are dealing with a unique situation in which the fuel is crumbled and has to be dug out in some cases, but the shipping practices are not a major technological problem.

Mrs. BOGGS. And you do have good relationships with the local authorities?

Mr. VAUGHAN. As far as we know. We talked to all the people along the route. We are going to use rail shipment in these specially designed casks that I described to you, and so I believe it can be an orderly process.

SPACE AND DEFENSE NUCLEAR POWER SYSTEMS

Mrs. BOGGS. You are requesting funds for four space and defense nuclear power systems. How much are you requesting for each of the four systems, and what is the total estimated cost of each?

Mr. VAUGHAN. The amounts being requested in Fiscal Year 1987 for each of the systems would be—excuse me just a second. I am looking for my breakdown.

Dr. Wilcox , do you have the specific breakdown that you might can give Mrs. Boggs?

Dr. WILCOX. Yes, in FY 1987 SP-100 is one of our major programs, and that is funded at $30 million in DOE's budget and $50 million from DOD. The DIPS or Dynamic Isotope Power System program is $13 million for the DOE program, and the multi-megawatt——

Mrs. BOGGS. How much from the DOD?

Dr. WILCOX. $15 million. The multimegawatt is a large reactor, a space reactor oriented development, funded at $23.7 million, for DOE and $22.5 DOD, and the multimegawatt terrestrial reactor is $3 million for DOE and $5 million for DOD.

Mrs. BOGGS. Are these four systems really necessary or are they just one of the items off of the "nice to have" list for the Defense Department?

Mr. VAUGHAN. No, Mrs. Boggs. As best we can understand it from our users—and we are not just taking their input casually at all—these are necessary and enabling power systems for the missions that are envisioned. The numbers Dr. Wilcox provided indicate that there is at least a 50 percent cost sharing by the defense customers, so they are contributing their money also. I think in 1987, for example, in comparison to DOE's total of approximately $70 million, the DOD and other contributed totals is something in excess of $90 million.

Mrs. BOGGS. Since the small nuclear power source reactor would be left unattended during its operations, what is the danger posed by such an operation, particularly from some dedicated type of terrorist group that wanted to obtain the materials in the reactor?

Mr. VAUGHAN. We have looked at that question. First of all, I am sure you recognize that they would be in extremely remote locations that are very difficult to access. Secondly, they will be in what I will call, for lack of a better term, a concrete tomb that makes it very hard to get to.

Further, the attractiveness to terrorists of trying to get special nuclear material does not typically deal with that material which is within a reactor, and operating as fuel. If they tried to remove the fuel without the proper precautions, it would be fatal.

Mrs. BOGGS. Can you tell us why the Air Force can't use conventional power generators that could possibly provide the needed capability, instead of developing the multimegawatt terrestrial reactor?

Mr. VAUGHAN. Many of the Air Force studies that have been conducted on that subject indicate that they are looking for a more reliable power supply, and one that is less logistically expensive in terms of fuel oil supplies and that type of scenario. That could be provided by a small nuclear plant, which would probably be kept on line for base power, and then shed the loads when you needed it for emergency situations.

Mrs. BOGGS. Thank you very much, Mr. Secretary. Thank you, Mr. Chairman.

Mr. BEVILL. The chair recognizes Mr. Fazio.

Mr. FAZIO. Thank you, Mr. Chairman. Mr. Vaughan, welcome.

Mr. VAUGHAN. Thank you.

Mr. FAZIO. I am sorry, I didn't realize Mrs. Smith had come in.

Mr. FAZIO. Mrs. Smith, please go ahead.

COST OF NUCLEAR VERSUS COAL-FIRED PLANTS

Mrs. SMITH. Thank you very much. I will be very brief.

What would the cost of generating power from new nuclear plants coming on line today compare with the cost of coal-fired plants?

Mr. VAUGHAN. Mrs. Smith, that is going to have to be up to the utility industry to sort out their priorities. For many years, if you look back at the nuclear power plants that were built in the '70s under more rational time schedules, they are generating power in most cases cheaper than coal-fired plants. Some of the more recent plants that have encountered delays have slightly higher generating costs.

The fuel cost, of course, for nuclear powerplants is the significant factor that makes them cheaper to operate, and it is the capital cost that offsets that on balance. It is for those reasons that it will be absolutely necessary to have a more rational nuclear plant licensing process and construction schedule, in order to bring those capital costs back into reasonable balance to make them continue to be competitive or ahead of the coal-fired plants. Obviously, in looking ahead to the cost of coal-fired generating plants, there are a number of unknowns in terms of factoring in the additional cost of clean coal-burning technologies, the potential impact of acid rain legislation and a number of factors like that, which also provide uncertainties.

Mrs. SMITH. I happen to come from one of the states that has more nuclear powerplants than most do, but they were built quite a while ago when there weren't quite as many regulations.

Mr. VAUGHAN. Yes.

Mrs. SMITH. I have no more questions, Mr. Chairman.

Mr. BEVILL. Mr. Fazio.

NUCLEAR ENERGY PRIORITIES

Mr. FAZIO. Thank you, Mr. Chairman.

There are a number of areas that I wanted to question Mr. Vaughan about but they have already been discussed, so I won't take as much time as I am afraid I usually do. But I did want to just go back to the question of priorities within the future of fission energy. I think Congress spoke pretty clearly last year, both the Science and Technology Committee and this committee, in terms of wanting to look at all three of the predominant future strategies. Obviously, that advice from Congress has been pretty much rejected by the administration. Is that simply a matter of fiscal restraints that are imposed on you?

Mr. VAUGHAN. First of all, I would not say that we rejected advice.

Mr. FAZIO. I wouldn't put those words in your mouth either, but the budget numbers reflect that.

Mr. VAUGHAN. We have not rejected the advice. I think the agenda is still pretty much as it was, and I also believe that we can continue our plan to do some of the critical assessment of the winners and losers among those designs as they exist today, although there are some key technology factors that absolutely must be solved before anybody would commit to one of those advanced plants. Nobody, certainly, wants to start on that until they are sure it is going to work. I would say the pace is stretched out, but we believe the pace is still ahead of the market as we see it.

Mr. FAZIO. I think it is probably ahead of the market for all three. I mean except in the context of the fact that we have cur-

rently light water reactors in the marketplace, an earlier type, more rudimentary design, and so I guess it leads me to ask: Why wouldn't we let the marketplace that is committed to light water reactors, carry them forward? If that in fact is their choice, why wouldn't the Department of Energy, as it so often tells us it has to do in other areas of energy development, be on the cutting edge of technologies that haven't been really in the marketplace, like liquid metal reactors, and certainly HTGRs?

Mr. VAUGHAN. We are still in those technologies.

Mr. FAZIO. Just barely.

Mr. VAUGHAN. There are some aspects of advanced and light water reactors, and the risk-based licensing approaches and safety approaches that are traditionally federal roles that go with those, that very frankly industry doesn't have quite enough incentive to do on their own, although they are spending significant funds.

Mr. FAZIO. In effect, because industry doesn't have any incentive to invest in these areas generally anyway, we are going to continue in an area that we have quite an investment in; isn't that correct? Let's be honest. Most people look at the facilities in Richland and Idaho Falls, and we understand the federal employee base that is committed, and this is a maintenance year.

We are not getting much money in the budget, so we are going to hold together the base that we have developed. We are going to keep those people and those plants funded. We don't have an investment in the other two to that extent, so we are not going to do it.

Mr. VAUGHAN. That is not quite accurate.

Mr. FAZIO. It is pretty close, though?

Mr. VAUGHAN. No. The facilities in Idaho and Hanford are principally liquid metal reactors.

Mr. FAZIO. That is why that program is keyed in a little bit more in the future in the budget?

Mr. VAUGHAN. I think in the near term, the potential applications of liquid metal reactors is probably ahead of the high-temperature gas-cooled reactors.

Mr. FAZIO. And will stay there based on the priorities that are based on our current configuration. If we had all the money that people in this area would like to have, obviously we would have three competitive markets, all of course contrived by government incentive at this time, but three fairly competitive ones, with different levels of cost sharing, but the history is different.

Mr. VAUGHAN. The history of all of them is different.

Mr. FAZIO. We have to deal with the history of who is there doing what today.

Mr. VAUGHAN. But in large part we are still trying to look more at market pull than government push.

Mr. FAZIO. Right now the market isn't doing much pulling, and we have to admit that, whether we blame it on the licensing process or the fact that we have declining oil prices and a return to that direction. But even when oil prices were high, for some reason we have leveled our growth of consumption of electrical energy, and so the market pull just hasn't been there. It really has given us an opportunity, if we wanted to take it, to do more basic research and be ready for the market pull when it comes. But I am

afraid we are not letting market forces impact on bureaucratic pressures.

Mr. VAUGHAN. But I believe that is exactly what we are doing, because the demand is, by any scenario you look at, going to pick up in the '90s.

Mr. FAZIO. I agree with you.

Mr. VAUGHAN. I think we have been quietly making some significant improvements without a lot of fanfare to be ready for that.

Mr. FAZIO. I look forward to seeing what—I hope I will be around and notice what is available—is ready to be pulled by the market when it comes back. But my sense is, right now, that we are not going to be much better prepared for that market pull than we are right now, because we are not really doing as much as I think you and I and others know we could be doing, if this were a high priority. Obviously, it isn't.

DEFENSE ACTIVITIES

What seems to be a higher priority is the involvement of the defense budget in the Department of Energy's overall budget, and certainly even in the energy R&D account for nuclear, we see a vast increase from last year, something in the neighborhood of $20.2 million up to $71.7 million. You have just outlined for Mrs. Boggs what those expenditures are.

Mr. VAUGHAN. Yes, sir.

Mr. FAZIO. Why do we have to have such a relatively, I think, easy cost-sharing relationship with DOD? They have got the bucks. Most of the applications, I think, are Star Wars SDI related. Why aren't we asking for a little more help out of the DOD budget this year?

Mr. VAUGHAN. Two comments, Mr. Fazio. First of all, as I commented in my opening statement, the increase that is there is what we had planned last year. It is not something that is sudden or unplanned, and those projects are aimed at meeting real needs that are understood to be there in the '90s. And, as I also commented, the cost sharing is at least 50 percent from the customers.

Mr. FAZIO. That is one customer that can afford to buy, I have to admit.

Mr. VAUGHAN. It is $90 million versus $70 million, approximately, in our Fiscal Year 1987 account. If you look historically at other Atomic Energy Commission and DOE programs, you go all the way back, for example, to the naval reactors development program. That is kind of a traditional cost sharing for the R&D phase. Ultimate procurement of products will be a DOD funding application.

Mr. FAZIO. Sure, but in terms of the R&D phase, even under the naval reactor systems program, that wasn't funded in this account, was it?

Mr. VAUGHAN. No, it is funded in a different account, but in DOE.

Mr. FAZIO. Sure, I know it is in DOE.

Mr. VAUGHAN. The traditional cost sharing program is the same and that is the analogy I was trying to draw.

Mr. FAZIO. You think the share the Defense Department put up for the Naval Reactor Program was about what we were going to put up?

Mr. VAUGHAN. I think the analogy is very comparable.

Mr. FAZIO. Could you provide for the record the information that would validate that assertion, but I am not sure whether that is right or not. I don't want to disbelieve, but I would like to see it in writing. It may be a good model to observe.

Mr. Vaughan. I would like to provide that for the record.

[The information follows:]

COST-SHARING OF THE R&D PHASE OF THE NAVAL NUCLEAR PROPULSION PROGRAM

The Naval Nuclear Propulsion Program is a joint effort of the Departments of Energy and Defense for the purpose of developing, applying, and controlling nuclear propulsion in Navy vessels. The Department of Energy, through the Atomic Energy Defense Activities appropriation, is responsible for development of reactor fuel and components. The Defense Department is responsible for all shipboard components and systems and unique naval aspects of reactor components.

Mr. FAZIO. The President keeps talking about SDI as a non-nuclear program, but that is not accurate if you look at the budget submission. What does he mean by that?

Mr. VAUGHAN. I don't think it is appropriate for me to speak for the President, but in terms of the budget we are dealing with today, we are dealing with the energy sources for enabling whatever SDI programs there are, and whatever the platforms, the platforms will need a certain amount of hotel load, propulsion capability to move into orbit, and capability for command and control whether it be on the ground or in the air. Those energy programs for power are somewhat independent of the nature of the directed-energy weapons, which are really what is referred to in the President's statement.

He is talking about the nature of the weapon as opposed to the nature of the energy sources.

Mr. FAZIO. I understand that. I think it needs to be clarified.

Before I go on and ask broader questions about the operation of nuclear plants in this country today and in the future, just one more return to the issue of our alternatives for the future of fission.

COST SHARING

Has anybody come to you with the kind of consortium we find in the case of the high-temperature Gas-Cooled Reactor Associates people putting money on the table trying to develop a specific research program with a specific development of a reactor in the future as a result of it?

We have other examples like that of cost sharing which seems to be not only the buzz word but what obviously we would like to see in the future of the Department of Energy.

Mr. VAUGHAN. So far Gas Cooled Reactor Associates has not put any money on the table, although they have worked on a program plan in which they indicate they are going to make such a proposal.

Mr. FAZIO. Is anyone else working on a program plan which would lead us to believe they will?

Mr. VAUGHAN. In the light water reactor area, for example, as I commented, the evolutionary advancements will not be those that require demonstration plants.

The commercial industry is putting more into the technology developments than we are; what DOE is doing is a good catalyst.

Mr. FAZIO. Don't you think the HTGR is a model of what you would like to see in terms of private utilities and manufacturing stepping up to the table?

Mr. VAUGHAN. It could be a very interesting model and when the time comes to do another demonstration plant, we would want to have a model such as that.

Mr. FAZIO. When do you think that will be?

Mr. VAUGHAN. You will remember, for example, the Clinch River Reactor project?

Mr. FAZIO. Yes.

Mr. VAUGHAN. That did have——

Mr. FAZIO. Oh, yes, yes.

Mr. VAUGHAN. That did have industry cost sharing as well as Federal Government involvement.

Mr. FAZIO. But nowhere near the percentages we are talking about.

Mr. VAUGHAN. Nowhere near the percentages that are being talked about.

Mr. FAZIO. When do you think the day will come when we will be interested in visiting that issue again, HTGR's at least, in the budget of the Department it is not a matter for consideration. That maybe is not true in this committee. But we will see how we do with deferrals.

Mr. VAUGHAN. I would say, for example, the advanced liquid metal converter designs, if we bring one to the demonstration phase, it will need to and will have to follow pattern similar to that in the HTGR's. There is an organization called Advanced Reactor Corporation which is in place to facilitate that.

The vendors who are doing some of those innovative designs are working with utilities who have expressed an interest and they are putting a lot of their own money into assessing the market share involved. That is probably a year or two behind the HTGR effort.

Mr. FAZIO. Do you envision in the 1990s, when you and I agreed we should see electrical energy generating plants, that all three of these alternatives will be on the table to choose among?

Mr. VAUGHAN. I would expect, from a practical point of view, there will have to be a restoration of the advanced light water reactor option to restore some of the health and vigor to the industry and the other areas will then follow from a more healthy industry.

Most of the people we talk to in the utility business, and in other segments of the industry, indicate that is pretty much the pattern.

Mr. FAZIO. So basically what you are saying is there will be one option available if they want to go nuclear and if they don't——

Mr. VAUGHAN. In the early 1990s I think that is right. In the early 2000s, you know, it may be a different picture.

Mr. FAZIO. I would be interested in getting industry input on this issue from the utilities, not from the people who will be making these various plants because they have already committed most of their R&D research bucks.

Mr. VAUGHAN. Yes.

NUCLEAR PLANT OPERATIONS

Mr. FAZIO. Just to conclude, obviously we have a lot of structural problems in the nuclear industry right now. I am very impressed that it is almost impossible to hire and retain the kind of personnel we need, particularly when you think in terms of the fact that many of the people who are paid to run nuclear plants are compensated at the kind of pay scales that are available for very, very different kinds of applications in most utilities.

In other words, we are not able to come up with the funds to hire them in the first place and sometimes not able to keep them, at least the competent people we need to keep a plant running efficiently, let alone to provide us with the margin of safety that apparently we need.

It is obvious that we need a lot of capital investment. It is kind of mind boggling for utilities to consider plants, not just nuclear, but large-scale plants these days, given the bond market and that may be taking care of itself to some degree, but so many other factors are involved in the marketplace.

Do you think we may be at a point where we need to have some very specialized firms develop and operate nuclear plants wholesale?

In other words, is it beyond the operations of a lot of utilities today? Should we be looking at perhaps some regional consortiums which would have a unique ability to develop and operate nuclear plants in effect providing the power to the utilities to try to raise the level of competence to what may be acceptable?

Mr. VAUGHAN. Let me make two comments. First of all—I don't have specific numbers at my fingertips—but the pay scale for reactor operators and supervisory personnel for nuclear powerplants is, I think, well above the norm for the utilities industry which recognizes that some special skills are required.

Mr. FAZIO. Acquiring the people seems to be very difficult. If you want to upgrade your capabilities, it is almost impossible to find anybody.

Mr. VAUGHAN. Many of the utilities are doing very well in operating their nuclearpower plants. The Institute for Nuclear Power Operations has been a very positive factor in helping that self-improvement by the industry. There are a number of programs which are under way.

The things you read about in the paper are more the minority than the majority.

Mr. FAZIO. I realize there are the Duke Powers, they do well and others don't do as well.

Mr. VAUGHAN. Yes, but you referred in your question to what some people have called the consortia or generating companies.

Mr. FAZIO. Yes.

Mr. VAUGHAN. There have been some advocates of those proposals and I think the commercial sector is going to have to help decide whether that is practical.

I have heard senior utility executives comment that such a concept may not be practical if they simply become a middleman with

a take-or-pay contract and don't have control over how well the plant is operated.

The larger companies would, I think, tend to favor continuing the present practice. It may well be that we would be wise not to proliferate the number of small utilities who have perhaps attempted to build and operate nuclear powerplants on their own without being part of a more experienced group and that may very well be the pattern that emerges.

RESEARCH DIRECTION

Mr. FAZIO. My final question, is the research being done at DOE targeted towards reducing capital expenditure, for example, or cutting down the lead time for construction or simplifying the management task? Are we working at some of those issues as we do our R&D in the Department of Energy?

These seem to be absolutely essential to the marketability of this research in terms of getting the kind of commitment to build and to proceed with the nuclear option.

Mr. VAUGHAN. The simple answer to that question is, yes. Those are major factors that are being considered in the new designs we are working on.

Mr. FAZIO. Would you again at some length provide that for the record, to document exactly what we are talking about in terms of all three of these options?

Mr. VAUGHAN. We will be glad to do that.

[The information follows:]

ADVANCED REACTOR CONCEPTS R&D GOALS

The Advanced Reactor Concepts research being done at DOE is aimed at reducing capital expenditures, reducing lead time for construction, and simplifying management. All concepts utilize design simplification, passive safety features that eliminate the need for complex engineered safety systems and a safety grade Balance of Plant, standardization, modularization, and other elements aimed at reducing plant capital cost to the point of competitiveness. The achievement of competitive plant capital costs is essential to the market acceptance of any nuclear plant. Through simplification, passive safety, reduction in complexity, standardization, and modularization, these plants can be constructed and licensed with much shorter lead times, providing not only faster on-line availability and earlier cash flows, but also reducing carrying charges for the purchasing utlilty. Simplification of design, reduced complexity, use of licensability, standardized modular designs, and shorter construction times all lead to simplified construction management due to the rapid learning curve associated with repetition and the minimum site construction requirements associated with modularity.

Mr. FAZIO. Thank you, Mr. Chairman.

Mr. BEVILL. The Chair recognizes Mr. Watkins.

Mr. WATKINS. Thank you, Mr. Chairman, and members of the committee.

Welcome. I notice on page 6 of your testimony that the chart there—this is what Mr. Fazio was also leading up to in some of his comments.

SHIFT IN PROGRAM PRIORITIES

If you look at the direction the budget is going on nuclear energy R&D, light water reactors is reduced by $7 million, $48 to $41; advanced reactor R&D from $128.5 to $49.5, about a $79 million re-

duction; space defense power systems jumps from $20.2 to $71.7; that is a $51 million increase.

Mr. FAZIO. That is the new marketplace.

Mr. WATKINS. Outer space, yes. Advanced nuclear systems increased by $4 million. The facilities reduced by $10 million.

Water cooled breeder reduced by $7 million, and the program direction increased by $1.3.

I just point that out to reemphasize for our own ears to hear that usually we put our money where the heart is, or where maybe some direction has been given and we have moved a great deal away from civilian to very dominating SDI programs.

I would like to ask this: programs and budget request, and if I get into classified areas let me know——

Mr. VAUGHAN. Sure.

Mr. WATKINS. Stop me if I do.

On the second phase it seems to me you make a statement that some of our activities have progressed from design to the more capital intensive hardware phase.

Are we into a large capital funding program?

Mr. VAUGHAN. Well, no. I think what that particular statement refers to is, the SP–100 program where we have been in the technology screening and selection phase, have picked the reference concept, and are now moving into the ground engineering test phase which is to demonstrate the validity of the concept prior to flight simulation test in the early 1990s.

If you look at the overall picture that you have described and put it into context, as I commented in my opening remarks, the bottom line of the energy supply R&D account, which is on the first page of the statement, is fairly level.

The remedial action programs have to be funded out of those accounts. Many of them are Congressionally mandated.

Those programs have been in the planning stage and higher priority projects have been under way. We have got to complete those projects for protection of the environment and many of them are in the phase where contracts are in place and work needs to move forward.

So if you will balance your total priorities, the space and defense programs are for specific near-term needs. They increase—that was the plan from last year. It is not a new factor. You have overall budget stringencies at work.

ENERGY INDEPENDENCE

Mr. WATKINS. Let's move to your third one, and again, I think something that concerns some of us. You have indicated that you are moving away from civilian reactor research and development programs; it has been reduced. But you say more sharply focused on a path exists to maintain nuclear power as robust options for the rest of this century.

Now, I know we all are gun shy but I think many of us are concerned about our fossil fuel existence and a lot of early studies a few years ago when we had the crisis, I think I know why we have a surplus now in oil and gas, but this is a time when many of our top scientists and research people say we have to become prepared

with alternative civilian sources of energy because the fossil fuels other than coal which we are having difficult getting back on line look like we are going to be focusing and winding down to a pretty low ebb when we need to be expanding and moving forward.

Mr. VAUGHAN. Well, as I discussed with Mr. Fazio, as we see the market for the rest of this century, I believe that the first step that has got to occur in the utility industry, and they will tell you the same thing, is a resurrection of the light water reactor option with some of the longer term advanced reactors probably being beyond the turn of the century in terms of actual market deployment.

I believe that the budget is balanced and paced to meet those needs.

Mr. WATKINS. You don't think there will be just an abrupt——

Mr. VAUGHAN. I don't believe there will be an abrupt change.

BYPRODUCT UTILIZATION

Mr. WATKINS. I have had an opportunity to work with some of your people, if I could say, and I understand the Office of Remedial Action and Waste Technology is proceeding with its civilian by-product utilization program and I want to compliment a couple of your people that I have worked with, Bill Voigt and Joe Coleman here in the Washington area and your consultant, Jack Savinsky from the Albuquerque field office.

I have learned a great deal more about that program and beneficial uses in the future, and I know it has been very helpful to me and the staff of the committee to have their expertise around.

I understand you have not requested any funds for this program for fiscal year 1987 and that you expect outside financing to be provided or to take up the slack with that.

How do you plan to do that? What are the requirements for this kind of funding?

Mr. VAUGHAN. Since Mr. Voigt is here with me and since you and he worked on one of the projects in Oklahoma, which is near to your heart, why don't I let Mr. Voigt respond to that question.

Mr. VOIGT. There are a number of activities being considered by states. For example, the State of Hawaii has before it, before the state legislative body, $2 million for their contribution to a food irradiator. The State of Florida is also giving consideration to some financial contribution.

There are a number of states that are looking at possible contributions to food irradiation and as this progresses, Mr. Watkins, I am hopeful that other states will desire to proceed and hence will come up with money to help the project.

Mr. WATKINS. You know, we have an oil industry in Oklahoma and I don't have to tell you what happened to that. The state budget is about $500 million—$550 million down and we are going to end up having to reduce even education by 10 to 15 percent.

That is a sad state of affairs to be in. But they are really grappling with where to find revenue just to stay afloat.

But I think it has got tremendous potential. I have been much more an individual reader and student of it here in the last year or thereabouts but I am looking forward to continuing to work with you and seeing what can be done because I think it might export a

lot of our agricultural products that we today are storing and can't get sold on the markets, export markets.

I would like to see movement in that direction. I think agriculture, USDA is more than cooperative in trying to move in that direction also.

Thank you, Mr. Chairman.

That is all I have.

Mr. BEVILL. Mr. Boner.

Mr. BONER. I have four questions I will submit for the record.

Mr. BEVILL. Anything further in the way of questions?

Mr. Secretary, you all might want to stick around while we turn to Mr. Rusche here since it is related. We may want to call on you again later, if you don't mind.

Mr. VAUGHAN. We will be pleased to do that.

[The following questions and answers were provided for the record:]

Mr. Bevill. The fiscal year 1986 budget initiated a major review of nuclear energy research priorities. Part of that was to be a selection process to identify candidate advanced reactor concepts. What has become of that initiative?

Mr. Vaughan. In an August 9, 1985, letter, Secretary Herrington requestd that the Energy Research Advisory Board establish an ad hoc panel to review and comment on the Office of Nuclear Energy's strategic plan for the future development of civilian nuclear power. The essence of DOE's draft Strategic Plan for Civilian Reactor Development is to establish an agenda of requisite actions and tasks for development of advanced reactor systems that can be acceptable and competitive in a future market. Among those actions and tasks under Objective 2 of the Plan is an evaluation of candidate innovative reactor concepts in order to select one or more for enhanced development and possible demonstration. Before such an evaluation can be performed, certain R&D tasks must be accomplished. While the pace of the program to fulfill that agenda must be adjusted to accommodate national priorities and budget constraints, it is the Department's intent to continue to operate our unique liquid metal reactor test facilities and conduct the R&D leading to advanced reactor systems at an appropriate time in the future. Our FY 1987 budget request supports the highest priority tasks that address key design features related to economic, technical and institutional issues. An overall strategic plan--revised based on

consideration of comments received--will be valuable in guiding and focusing DOE's civilian reactor development programs, in helping assure complementary efforts by the private and public sectors, and in maintaining goals and objectives to ensure effective utilization of funds.

STRATEGIC PLAN

Mr. Revill. What were the recommendations of the "Landis panel" on the strategic plan to ERAB?

Mr. Vaughan. John Landis chairs the ERAB Civilian Nuclear Power Panel that is reviewing the Draft Strategic Plan for the Civilian Reactor Development Program. The panel has not submitted its report to Secretary Herrington; however, from the public meetings held to date, DOE believes that the report will be supportive of the direction and focus of the Department's civilian reactor research and development program.

Mr. Bevill. What were the recommendations of the "Taylor panel" on advanced reactors to ERAB?

Mr. Vaughan. John Taylor chairs the Advanced Reactor Development Subpanel of ERAB's Civilian Nuclear Power Panel. Mr. Taylor spoke to the ERAB panel at a public hearing in late January about the subpanel's report, which was not available at that time. The recommendations that Mr. Taylor described are consistent with the direction and focus of DOE's advanced reactor systems program.

Mr. Taylor's comments strongly supported the need for aggressive advanced reactor research and development in several areas. Emphasis was placed on the continued development of economically superior, modular factory fabricated, and inherently safe systems that can utilize long-life cores with either oxide or metal fuels and provide resistance to proliferation. Continued international cooperstive arrangements, especially as they relate to the breeder, were also supported.

The report of this subpanel will be used, as appropriate, by the whole panel in developing its final report.

Mr. Bevill. What is the DOE response to each of these recommendations?

Mr. Vaughan. The Energy Research Advisory Board has not yet made its recommendations to the Secretary.

DEMONSTRATION-SCALE PLANT

Mr. Bevill. Is DOE currently considering financing a demonstration-scale advanced reactor?

Mr. Vaughan. The draft Strategic Plan, to which I earlier referred, remains valid. On the agenda of items proposed by the Plan are four activities which must be completed before it is logical to consider building any demonstration scale advanced reactor. These are completion of sufficient R&D and key feature testing to permit a thorough evaluation of the viability of the concepts, completion of the evaluation, performance of additional design and regulatory interactions to define and minimize risk and to establish licensability, and, finally, to evaluate private sector interest at that time to support and proceed with further development, design, and demonstration of a specific reactor plant. It would be premature to consider proceeding with any demonstration reactor now.

When the time is appropriate to consider proceeding with a demonstration reactor, one of the key considerations would be the degree of cost sharing that the private sector could provide. The Department does not believe that full Federal funding of such a reactor demonstration is appropriate.

Mr. Bevill. How much would you estimate a demonstration-scale advanced reactor would cost?

Mr. Vaughan. Current preliminary cost assessments for detailed design and construction of LMR and HTGR demonstration-scale advanced reactors range from $600 to $900 million, depending on the power level of the design and exclusive of supporting R&D costs.

Mr. Bevill. How long would it take to design, fabricate, and construct such a project?

Mr. Vaughan. Our estimates to date show that such projects would require approximately 2 to 3 years for detailed design, 3 to 4 years for construction, and 2 years of operational testing.

Mr. Bevill. Which of the many advanced reactor concepts would be viable candidates for such a demonstration?

Mr. Vaughan. The advanced reactor concepts that would be viable candidates for an initial demonstration plant include the modular HTGR, the small modular LMR, the Large Scale Prototype Breeder, and an advanced LWR. However, as I mentioned in my answer to your previous question, we do not believe that any of these reactor concepts will be ready for demonstration until certain R&D, evaluation, design and NRC interactions are completed.

ADVANCED REACTOR CONCEPTS

Mr. Bevill. What is the most desirable size advanced reactor to develop (100 MWe, 300 MWe, 500 MWe, 1,000 MWe)?

Mr. Vaughan. Large reactors--1,000 megawatts electric and up--tend to have economies of scale that make them more economical in terms of life cycle generating costs. The new modular concepts appear to have the ability to offset those economies of scale through maximum shop fabrication and minimum site fabrication while reducing plant investment and utility financial risk. Our studies indicate reactors in the 100 to 400 megawatt range can be economically competitive with other forms of power generation due to relatively low capital costs, matching of load growth curves, and low operating costs. The design concepts currently serving as guides are the 1,370 megawatt Large Scale Prototype Breeder, the Rockwell 135 megawatt modular PRISM, General Electric's 350 megawatt modular SAFR, and a 140 megawatt modular HTGR.

As discussed in our draft Strategic Plan, assessment of market needs, which includes economics and plant size, will be part of our evaluation of these and other candidate concepts.

Mr. Bevill. How would DOE determine the optimum advanced reactor concept for the Federal Government to pursue and what role should the Federal Government take in so doing?

Mr. Vaughan. Ultimately, the market will determine which advanced concept or concepts are the most advantageous to pursue. At the moment, Advanced Light Water Reactors, the modular High Temperature Gas Reactor, and the Liquid Metal Reactor, the Large Scale Prototype Breeder have attributes which offer the potential of revitalizing the nuclear option, and DOE is conducting R&D on each. The Advanced Light Water Reactors are considered to have the most near-term potential for commercial deployment and would likely not require a demonstration plant. One approach to evaluating alternative concepts was outlined in DOE's Draft Strategic Plan for Civilian Reactor Development, which is currently being reviewed by the Energy Research Advisory Board. In this approach, continued interaction would be maintained with industry, utilities, the NRC, and others to establish a consensus, evaluation, and identification process to determine the optimum advanced concept for enhanced development, including detailed design and possible construction of a demonstration or prototype plant. Concept evaluation criteria and identification of the optimum advanced design would be based on cost competitiveness, technical risk, degree of passive safety, ease of licensability, and degree of investment protection. An additional criterion used in evaluating candidate concepts would be the degree of cost sharing proposed by the private sector. It is possible that more than one concept could be chosen for continued design and construction

if the cost-sharing arrangements were favorable and the concept satisfied the other criteria. The role of the Federal Government would be to conduct the evaluation to make the final decision using appropriate input and participation from industry, national laboratory and independent, competent, public and private sector representatives.

FUNDING LEVELS

Mr. Bevill. For each element of the funding request, provide FY 1985, 1986, and 1987 funding levels, a description of exactly what is to be done with the funds and where it will be done.

Mr. Vaughan. I would be pleased to provide that information for the record.

(The information follows:)

NUCLEAR ENERGY RESEARCH AND DEVELOPMENT

Program Element	($ in Millions) FY 1985	FY 1986 Estimate	FY 1987 Request
Light Water Reactors	$51.5	$48.1	$41.0

Safety and Licensing ($11.0):

- o Complete examination of severe fuel damage tests. Work is to be done primarily at EG&G, Argonne National Laboratory (ANL), and Hanford Engineering Development Laboratory (HEDL).
- o Apply severe accident methodology to assessment of advance LWR's. Work is to be done primarily at the Idaho National Engineering Laboratory (INEL).
- o Develop risk-based licensing techniques. Work is to be done primarily at the Sandia National Laboratory (SNL).
- o Provide technology for extending plant life. Work is to be done primarily at SNL.
- o Support nuclear and economic regulatory reform including support of legislation. Primary contractors are to be determined.

Advanced LWR ($18.0):

- o Develop configuration and parameters of more passive cooling system and perform verification testing. Primary contractors for thie and the following advanced LWR efforts are to be determined.
- o Provide support for certification of advanced designs.
- o Develop improvements in construction for cost, schedule and construction quality assurance.
- o Apply state-of-art advances in instrumentation and control.

Three Mile Island (TMI) R&D ($12.0):

- o Conduct off-site examination of damaged TMI-2 reactor core. Work is to be done primarily at INEL.
- o Provide on-site support for completion of refueling by GPU and for core sample acquisition. Work is to be done primarily at INEL.
- o Conduct standard-problem comparison on understanding of TMI-2 accident Work is to be done primarily at INEL.

Advanced Reactor R&D	$158.7	$128.5	$49.5

Reactor Systems ($23.6):

- Continue to pursue passively safe, cost-effective, licensable designs. Work is to be done primarily at General Atomic (GA), General Electric (GE), and Rockwell International (RI).
- Continue advanced control technology activities, including development of smart sensors, artificial intelligence, multi-module controls, and fiber optics for use in advanced nuclear powerplants. Work is to be done primarily at Energy Technology Engineering Center (ETEC), Oak Ridge National Laboratory (ORNL), Universities (U), and HEDL.
- Continue development and application of remote maintenance and operation technology through laboratories, university, and industrial teaming efforts to reduce maintenance time, operations costs, exposure of plant personnel to radiation, and enhance the safety of these personnel. Primary contractors are to-be-determined.
- Conduct testing of absorber assemblies, EM and shrouded inducer pumps, heat exchangers, and steam generator leak detection system. Work is to be done primarily at Combustion Engineering (CE), Atomics International (AI), GE, GA, ANL, ETEC, and HEDL.
- Continue international collaboration efforts, including obtaining MONJU design and engineering data applicable to advanced U.S. reactor efforts and the HTGR development programs with Federal Republic of Germany and Japan, and initiating private sector arrangement between Japan and U.S. on a cost-shared basis for advanced reactor design innovations. Work is to be done primarily at Burns and Roe (B&R), HEDL, ORNL, GA, GE, RI and Westinghouse (W).

Core Systems ($14.4):

- Continue the modification and validation of the thermal hydraulic code development program including initiation of priority tests to support advanced reactor designs. Work is to be done primarily at ANL, ETEC, RI, W, and U.
- Modify and update neutronics (steady-state and transient), structural, safety and seismic methods and computer codes to meet advanced reactor concept program requirements. Work is to be done primarily at ANL, W, and U.
- Develop high temperature structural design methods, conduct critical experiments on cores, modify instrumentation development program through evaluation of automated surveillance and diagnostics methodology and initiate testing of candidate instruments to meet needs of advanced reactor programs. Work is to be done primarily at ORNL, ANL, and U.
- Develop and demonstrate core designs and safety features which assure self-acting inherent responses to a wide range of off-normal operating and safety transients. Work is to be done primarily at ANL and HEDL.

Fuels and Materials ($11.5):

- Conduct transient TREAT tests on advanced oxide fuel pins, advanced cladding materials and metal fuels and continue metal fuel development in support of advanced reactor designs. Work is to be done primarily at ANL.
- Continue the U.S./Japan Fuels and Materials irradiation programs. Irradiate advanced cladding/duct alloys, MONJU fuel, and long-life fuel. Irradiate long-life fuel in JOYO. Work is to be done primarily at HEDL.
- Continue criticality experiments at critical mass laboratory in support of U.S./Japan exchange agreement. Work is to be done primarily at the Pacific Northwest Laboratory (PNL).
- Examine the potential application of remote systems technology being developed at the Integrated Equipment Test Facility to all advanced reactor requirements. Work is to be done primarily at ORNL.

Space and Defense Power Systems	$8.8	$20.2	$71.7

SP-100 (GES) ($30.0):

- Conduct fuels and materials irradiation testing. Work is to be done primarily at ORNL.
- Develop fuels technology and demonstrate fuel pin fabrication capability at needed production capacity and perform metallurgical examination and thermal creep testing of irradiated materials and fuel pins. Work is to be done primarily at Los Alamos National Laboratory (LANL) and HEDL.
- Conduct criticality experiments and complete GES test site environmental documentation, procure necessary capital equipment, and initiate GES facility modifications. Work is to be done primarily at HEDL and industrial contractors are yet to be determined.
- Complete SP-100 reference flight system design and conduct safety analyses, initiate GES design and development activities, procure GES materials, and begin GES component fabrication. Contractor to-be-determined.
- Perform quality assurance and research audits of design, systems engineering, safety and technology development activities. Work is to be done primarily at Jet Propulsion Laboratory (JPL), SNL, and LANL.
- Complete Phase II detailed planning, initiate Phase III planning, and conduct mission/user interfacing. Work is to be done primarily at JPL.

Small Nuclear Power Source Demonstration Project ($2.0):

- Complete fabrication and assembly of demonstration reactor unit and initiate fuel loading. Contractors to-be-determined.

Dynamic Isotope Power System ($13.0):

- Conduct studies and analyses necessary to support selection of the power conversion cycle between Brayton and Organic Rankine concepts; and evaluate key technical problem areas, survivability potential, and safety assurance. Contractors for this and the following work are to be determined.
- Test key subassemblies such as foil bearings, non-condensible gas separators, zero gravity condensing techniques, and heat source-exchanger interfaces.
- Define power system requirements and spacecraft interfaces; initiate preliminary designs for baselining component development and fabrication of the engineering unit.
- Initiate component development and critical testing of dynamic conversion equipment, controls, sensors, exchangers, radiator sections, insulations, bearings, condensers, separators, emergency cooling, and abort safety devices.

MMW Space Power System ($23.7):

- Complete out-of-core and thermal reactor testing, fabricate test assembly and capsules, and initiate fast flux testing. Work is to be done at ANL, HEDL, LANL, and to-be-determined industrial contractors.
- Complete design and fabrication of thermionic fuel element capsule for in-thermal reactor testing. Work is to be done at ANL, HEDL, and to-be-determined industrial contractors.
- Perform advanced concept test planning, test operations, and develop safety reports. Work is to be done at ANL.
- Complete initial feasibility assessment of MMW fuels and materials. Work is to be done at ANL, PNL, LANL, HEDL and to-be-determined industrial contractors.
- Develop surety guidelines and specifications and assess systems for adequacy of surety design specifications. Work is to be done at LANL and to-be-determined industrial contractors.
- Develop calculational methods from existing data and techniques in the areas of neutronics and control and reactor thermal hydraulics. Work is to be done at ANL and PNL.
- Complete initial assessment of advanced shielding materials and shield cooling systems leading to a selection of candidates.

MMW Terrestrial Powerplant Project ($3.0):

- Complete preliminary design work leading to concept(s) selection. Work is to be done at INEL and to-be-determined industrial contractors.

Advanced Nuclear Systems $26.4 $19.5 $23.6

Radioisotope Thermoelectric Generators (RTG, $22.4):

- o Perform flight data analyses and RTG power predictions in support of Galileo/Ulysses missions. Work is to be done at GE.
- o Continue development of a modular RTG for future NASA/DOD missions. Work is to be done at GE.
- o Modify/upgrade fuels facilities and tooling for future RTG and DIPS missions; develop heat source improvements and initiate preliminary design; maintain heat source production readiness. Work is to be done at Mound, Savannah River Laboratory (SRL), and ORNL.
- o Conduct reliability and quality assessments, thermoelectric materials research, and operations analysis. Work is to be done at Ames, Fairchild Industries (FI), SNL, and GE.
- o Perform heat source fuels and plutonium environmental testing and safety analyses. Work is to be done at Naval Ocean Systems Command, and Applied Physics Laboratory.

Special Applications ($1.2):

- o Continue development of technology for terrestrial RTG's. Work is to be done at Teledyne Engineering Systems.

Facilities $133.9 $132.2 $121.8

- o Work that is to be done at the various facilities is provided in other text that follows.

Water Cooled Breeder $25.0 $19.0 $13.8

The Water Cooled Breeder FY 1987 budget request provides final funding for this program. The remaining work is expected to confirm that breeding can be achieved in a light water nuclear powerplant using thorium, a plentiful fuel for which there has been no major energy-related use. The major areas of work are: defueling activities and core evaluation, both of which are in progress at the Bettis Atomic Power Laboratory in Pittsburgh, Pennsylvania, and its Naval Reactors Facility at the Idaho National Engineering Laboratory.

Core Evaluation ($10.2):

- o Defueling activities in FY 1987 will consist of spent fuel handling and shipment to the Idaho Chemical Processing Plant for long-term storage; cleaning up light water breeder reactor facilities; and publishing final reports on defueling activities.

Defueling Activities ($3.6):

- Core evaluation work will include completing nondestructive assay of about 3 percent of the light water breeder core's fuel rods to confirm breeding; disposing and cleaning up examination equipment; completing core and structural materials examinations; and documentation of the final program results for use by industry.

REMEDIAL ACTION AND WASTE TECHNOLOGY

($ in Thousands)

Program Element	FY 1985	FY 1986 Estimate	FY 1987 Request
Formerly Utilized Sites	$17,800	$18,955	$25,600

In FY 1987, the Formerly Utilized Sites Remedial Action Project will complete characterization, engineering, and remedial action on various vicinity properties associated with the Maywood, New Jersey, site, and will complete cleanup of Sheffield Brook to the Pompton River for the Wayne, New Jersey, site. At Colonie, New York, design engineering and remedial action will be completed for the remaining vicinity properties, and site characterization will be completed at the Hazelwood, Missouri, site. Remedial action will be initiated at the Albany, Oregon, site and approximately 40 percent of the work will be completed. Site characterization and preliminary engineering will be completed the St. Louis Airport Disposal Site near St. Louis, Missouri, Disposal site activities will include completion of area surveys and selection of three candidate sites in New Jersey, and continuation of area surveys in New York.

Grand Junction Remedial Action Project	$ 1,500	$ 900	$ 800

The FY 1987 budget request represents the required funding to complete the program. At this level of funding the Grand Junction Remedial Action Project will complete remedial action on all remaining properties, currently estimated at 8 new properties and 8 reassignment locations. Final verification surveys will be completed in FY 1988.

Uranium Mill Tailings	$60,700	$91,400	$126,000

Specific accomplishments planned for FY 1987 include site surveillance and maintenance for Canonsburg, Pennsylvania. At Shiprock, New Mexico, remedial action will be completed and surveillance and maintenance will be initiated. At Salt Lake City, Utah, processing site remedial action as well as vicinity property work will be completed. In Colorado, the Durango processing site remedial action will be 25 percent completed and 70 percent of vicinity property remedial action will be completed. At Gunnison, engineering design will be completed and processing site remedial action will be initiated. In Grand Junction, 5 percent of the processing site remedial action will be completed and work at 800 vicinity properties will be initiated. In Rifle the Remedial Action Plan, conceptual design, environmental documentation and

design engineering will be completed; vicinity property engineering will be initiated. In Riverton, Wyoming, engineering design will be completed and processing site remedial action will be initiated. In Tuba City, Arizona, vicinity property work will be completed, as will 20 percent of the processing site remedial action.

Processing site remedial action will be initiated at Ambrosia Lake, New Mexico, and Mexican Hat, Utah. Processing site remedial action will be 85 percent completed and work on 6 vicinity properties will be completed at Lakeview, Oregon. At Naturita, Colorado; Falls City, Texas; Green River, Utah; Slick Rock, Colorado; Belfield/Bowman, North Dakota; and Maybell, Colorado, the Remedial Action Plan, conceptual design, and environmental documentation will be completed and engineering design will be initiated. At Lowman, Idaho, and Spook, Wyoming, work will continue on environmental documentation and engineering design will continue.

Surplus Facilities	$29,250	$39,931	$56,400

In FY 1987, the Surplus Facilities Management Program will continue dismantlement of the Shippingport Atomic Power Station at at Shippingport, Pennsylvania, at a pace consistent with the project schedule to complete by May 1990. At the Weldon Spring, Missouri, site, remedial action work will begin at the Weldon Spring Quarry and demolition of non-radiologically contaminated buildings will be initiated at the Chemical Plant. The 10-year project for decontamination and decommissioning (D&D) of the Advanced Nuclear Systems and Projects Division (ANSPD) areas at the Mound Facility in Miamsburg, Ohio, will be essentially completed, and the D&D project at the Center for Energy and Environmental Research in Puerto Rico will be completed. Remedial action at the Monticello, Utah, mill tailings site will be initiated and clean up of contaminated vicinity properties will continue. D&D will be initiated at the Ultra High Temperature Reactor Facility at Los Alamos, New Mexico, the SNAP-8 Test Facility at Santa Susana, California, the Experimental Boiling Water Reactor at Argonne, Illinois, and the Power Burst Facility at the Idaho National Engineering Laboratory.

West Valley Demonstration Project	$47,150	$61,581	$79,000

The objective of the West Valley Demonstration Project is to demonstrate solidification for disposal of high-level nuclear wastes under the provisions of Public Law 96-368, the "West Valley Demonstration Project Act" enacted in 1980. The project will carry out an integrated production-scale development and demonstration project for treating the alkaline and acidic high-level liquid nuclear wastes at the Western New York Nuclear Service Center, near West Valley, New York.

Major activities embodied in the project include: (1) necessary decontamination required to prepare existing facilities and equipment at the

Center to accommodate the solidification project; (2) removal of the wastes from the underground storage tanks; (3) development, design, construction, and operation of systems and necessary supporting facilities for the solidification of the wastes; (4) acquisition of containers for the permanent disposal of the solidified waste; (5) temporary storage and transportation of the solidified waste to an appropriate Federal repository for permanent disposal; (6) decontamination and decommissioning (D&D) of the waste tanks, facilities, hardware, and material used in carrying out the project; and (7) disposal of low-level waste (LLW) and transuranic (TRU) wastes produced from project activities.

The FY 1987 requested funds will be used to complete procurement of equipment and systems and related construction for processing supernatant; complete procurement and construction of vitrification systems and LLW processing systems. Nonradioactive testing of the component test stand and decontamination of several major cells for reuse by the project will continue and installation in decontaminated plant areas and cells of equipment for HLW interim storage, size reduction, and TRU decontamination will begin. Specifically, the following tasks will be performed:

(1) HLW Solidification: Procure sludge mobilization and removal equipment, make several required penetrations to the roof of tank 8D-2, install removal equipment, and issue equipment operating procedures. Process supernatant beginning in early- to mid-FY 1987; the supernatant represents approximately 90 percent of the volume and 50 percent of the radioactivity contained in the underground storage tanks. Complete a major portion of the radioactive conversion engineering and design for the Component Test Stand (CTS). Complete construction of the CTS shield walls and fabrication and delivery of vitrification process components. Begin construction of the tunnel connecting the CTS and the Chemical Process Cell (CPC) HLW interim storage area and begin installation of utilities. Begin modifications to the CPC in preparation for equipment installation.

(2) Decontamination and Decommissioning: The Project strategy is to conduct clean out of the hot cells on a schedule which matches reuse of the hot cells. Decontamination and painting of the CPC, completed by mid-year FY 1987, will be followed by decontamination of the EDR in the fourth quarter of FY 1987. Availability of these two cells will permit start of modifications to the CPC for interim storage of HLW. Refurbishment of the Fuel Receiving Station will be partially complete, permitting installation of initial size reduction equipment. Survey and start of decontamination of other cells will be consistent with overall cell needs.

(3) Site Operations: Efforts in this area will increase modestly in FY 1987 as additional project systems are brought into productive operation. New efforts are associated with full operation of the CTS and the radwaste treatment system for solidifying LLW into cement. Continuing efforts include operation and maintenance in support of the plant utilities room, cooling tower, warehouse, process plant ventilation system, quality assurance lab, alpha lab, analytical cells, HLW tank farm, sewage treatment plant, existing low-level waste treatment system, air compressors, diesel generator, water

treatment plant, process building offices ventilation system, fire pumps, and the environmental, analytical chemical and radiochemical laboratories. Purchases for the year to support overall site operations will include chemicals for water, sewage, and LLW treatment, anticontamination clothing, filters, and operations equipment to support supernatant and sludge treatment.

To support the HLW solidification, decontamination, site operations and LLW/TRU waste handling activities, major efforts are required in the areas of industrial hygiene and safety, quality assurance, procurement contracts, radiological surveillance, environmental monitoring, laboratory analysis, personal dosimetry, and physical security and safeguards.

(4) Low-Level and Transuranic Waste Handling: Refurbishment of the Fuel Receiving Station will be partially complete and installation of size reduction equipment started. The Cement Solidification Subsystem will be in full operation throughout FY 1987 and the Liquid Waste Treatment Subsystem will be operational by mid FY 1987.

In summary, the West Valley Project will continue an aggressive pace in FY 1987 without compromising the schedule or the dedication to the protection of both workers and the environment. In particular, the Project goals include the following:

- Minimize the Total Project Cost Estimate.
- Maintain the earliest feasible schedule for start of solidification consistent with available funding for equipment procurement and construction.
- Procure sludge removal and mobilization equipment, start waste tank modifications, and start equipment installation.
- Process supernatant beginning in early- to mid-FY 1987.
- Continue nonradioactive testing of the Component Test Stand; complete a major portion of the radioactive conversion engineering and design.
- Begin installation of size reduction/TRU decontamination system.
- Perform hot cell decontamination and modifications as necessary to support the above without significant new construction.

Low-Level Waste	$ 6,100	$ 4,570	$4,000

The goal of the Low-Level Waste Program is to facilitate the establishment of a reliable nationwide system for management of civilian low-level radioactive waste (LLW). Public Law 96-573, the "Low-Level Radioactive Waste Policy Act," assigned States the responsibility for assuring disposal capacity for low-level radioactive waste generated within their borders. The formation of regional compacts to satisfy this responsibility was encouraged by the Act. Presently, only three LLW disposal facilities operate in the commercial sector. The United States will exhaust its existing disposal capacity in one or more of these facilities by the early 1990s if the current disposal system is not expanded. It is also recognized that technology exists today to dispose of LLW safely, but continued improvements in specific practices,

techniques, information, and procedures will result in a more efficient, safe, and effective system for LLW management and disposal. Additionally, several regional compacts specifically require that disposal facilities employ alternative technologies, other than shallow land burial currently being practiced at the three operating sites, for disposal of low-level waste.

It is assumed that States will have joined regional compacts or decided individually to manage their own LLW in 1986. Beginning in FY 1985 support for compact development was phased down significantly. Since no State or region has identified a new LLW disposal site, and given the 3-5 years required for facility construction and licensing, it is unlikely that a new facility could become operational before 1990. Therefore, DOE assistance will be directed at helping States site new LLW disposal facilities and assisting in the evaluation of appropriate waste treatment and disposal technologies. States and/or regional compacts are expected to assume the regional management costs for their disposal sites, general technical improvements, and operation of the overall system through appropriate user fees.

In December 1985, Congress passed the "Low-Level Radioactive Waste Policy Amendments Act of 1985." This legislation assigns several new responsibilities to the Department relating to management of civilian low-level waste, assistance to regions and States, and annual reporting to the Congress on how low-level waste is being managed in the U.S.

The FY 1987 budget request of $4,000,000 will continue to provide technical support and assistance to States and regions for the development of new LLW disposal facilities. This support will be provided primarily by the Idaho National Engineering Laboratory.

Waste Treatment	$6,265	$6,206	$ 0

The goal of the Waste Treatment Program, over the past 5 years, has been to develop and transfer technologies for the treatment and immobilization of nuclear wastes in forms acceptable for transportation, storage, and disposal. This included identification and characterization of the types of nuclear wastes requiring treatment; developing new waste treatment technologies; evaluating the developed technologies in terms of reliability, efficiency, cost effectiveness, and adequacy in meeting environmental, safety, and health protection requirements; and providing a technical resource for other Departmental waste management programs. Efforts have been focused on determining the long-term reliability and maintainability of a prototypical high-level waste treatment system, on testing and selecting acceptable high-level waste forms for storage or disposal, and on transferring treatment technologies to specific Departmental waste management programs such as the West Valley Demonstration Project.

In FY 1987, radioactive testing of the HLW vitrification system at the Pacific Northwest Laboratory (PNL) will be terminated and the system shut down. Reports on research results obtained in FY 1986 will be completed.

Reports on research results obtained in FY 1986 will be completed. Commitments to the Federal Republic of Germany will be met; the bilateral agreement with Japan on ceramic melter testing may have to be terminated.

Byproducts Utilization	$ 0	$ 4,811	$ 0

The goal of the Byproducts Utilization Program, as provided by Congress, is to develop and transfer technology for the beneficial uses of nuclear waste byproducts. Irradiation of food and other agricultural commodities will be emphasized in cooperation with States, other Federal agencies, and private sector organizations. Efforts will be focused on establishing demonstration commodity irradiation facilities in States selected on their nearness to major agricultural commodity production and processing centers. Cooperative funding will be sought from the private sector. Also the program will focus on developing an adequate U.S. based supply of irradiation sources for commodity irradiations.

LWR DEVELOPMENT

Mr. Bevill. What is the capability of industry to conduct LWR research?

Mr. Vaughan. I believe that the industry still has the capability to perform required LWR research; however, the incentive to develop new product lines needed to keep the nuclear option viable is not present.

Traditionally, the source of R&D funds is the prospect of business growth--in other words, a new market. The structural change in electrical growth from 7 percent to 2.5 percent per year after the oil shock and the regulatory problems have eliminated any certainty of new business. Therefore, there is limited incentives for R&D devoted to advancing LWR systems.

Available R&D funding is largely devoted to existing problems. Top industry priorities are operating plants and plants under construction. Therefore, R&D funding on advanced LWR systems is increasingly difficult to justify by industry even though the more likely path for the first step to revitalize the nuclear option is with improved LWRs.

Mr. Bevill. Is this type of research consistent with the Administration's policy of supporting only "long-term, high risk" R&D?

Mr. Vaughan. Yes. By virtue of the status of the nuclear industry today, "long-term, high risk" has an entirely different context for nuclear R&D. In a setting where the users of the technology are quoted as saying that no more nuclear plants will be ordered under present circumstances, virtually any R&D on new product lines or new ways to solve safety issues takes on an element of long-range, high risk R&D.

Mr. Bevill. What is involved in completing the LWR designs and how much is requested for FY 1987?

Mr. Vaughan. Forty-one million dollars is requested under the categories of Advanced LWR technology, safety and licensing, and TMI R&D. Each of these efforts will contribute to the development and ultimate certification of advanced LWRs.

Two classes of Advanced LWR designs are under development by industry. The first includes large LWRs incorporating the latest technology. U.S. companies have a program underway which will complete these designs and gain their acceptance by utilities and regulatory bodies by the end of this decade. The second class includes mid-sized plants in the 400 to 600 megawatt electric power range. Development of these mid-sized plants is at an earlier stage. Completion of these more innovative designs, will require some component testing and considerable design development. It is estimated that such designs will be ready for the marketplace in the early 1990s.

Mr. Bevill. Discuss the cooperative program with industry for LWR development.

Mr. Vaughan. Industry is developing Advanced LWR's and making plans for their certification and acceptance by utilities. DOE is supporting the industry program by performing supporting technology on innovative design features. A DOE/EPRI Memorandum of Understanding has been executed which delineates these roles. A copy of the Advanced Light Water Reactor Strategy document has been provided to the Subcommittee.

ADVANCED REACTOR DEVELOPMENT

Mr. Bevill. The budget request for FY 1987 is $79 million below the FY 1986 appropriated. Since this moves so close to termination of many of these activities, why should any funding be provided?

Mr. Vaughan. It is true that the FY 1987 request is sharply reduced when compared to FY 1986 appropriations. However, this reduction is partially offset by an increase of about $50 million for Defense Nuclear Systems in FY 1987 reflecting a redeployment of some of the civilian nuclear program scientists, engineers, and facilities to meet the nearer term needs of the Strategic Defense Initiative research and development phase.

The reduced Advanced Reactor Development request reflects a stretchout as well as a redeployment. This is a reasonable and proper action considering the temporary surplus in utility generating capacity, the opportunity to benefit from technology developed in defense nuclear power systems, and the need to reduce government outlays.

However, the Department strongly believes that the Advanced Reactor Development should be continued. The recommended FY 1987 program will pursue the goals of inherent safety, reduced generating costs, short construction schedules, advanced technology for improved reliability and simplicity of operation. There is no question that the next generation of plants, beyond Light Water Reactors, will need these beneficial safety,

economic, operational, and environmental attributes if U.S. nuclear technology is to compete domestically and in the international market place.

The goals of the program have not changed. The achievements in the program have been remarkable in their degree of success. Our fuel performance has exceeded lifetime expectation. Our pumps and steam generators are working reliably. Our inherent safety technology programs are showing dramatically encouraging results and attracting worldwide attention. Our innovative designs, the result of industry/laboratory/university collaboration, serve to integrate and guide the technology development. Work is intensive and shows every promise of producing a "product line" of generating plants for the world market that will reclaim U.S. leadership in civilian nuclear power technology, products, and industry. The technology will be needed even if the exact timing is difficult to predict. We have high confidence in the success of this development and cannot recommend that the government quit the game when we are achieving such dramatic successes in reaching the program goals.

Mr. Bevill. Who are the industry participants in the HTGR program?

Mr. Vaughan. The industry participants in the HTGR program are GA Technologies, General Electric, Combustion Engineering, Bechtel National Incorporated, Stone and Webster Engineering, and Gas Cooled Reactor Associates.

Mr. Bevill. What, exactly, will the $25.0 million requested in FY 1986 be used for?

Mr. Vaughan. The funds in FY 1986 will be used to develop the reference design and technology necessary to support the submission of a Preliminary Safety Information Document, or PSID, to the NRC by the end of the fiscal year. This funding level will enable us to complete and issue the PSID to the NRC for review; complete a series of 18 briefings to NRC staff and the ACRS on HTGR design and performance; complete and issue the Regulatory Development Plan for NRC review; complete and issue Interim Conceptual Design and Safety Assessment Reports; initiate the Japan/U.S. Cooperative Fuel Performance Test Program, including preparing for irradiation tests of fuel under transient conditions; continue the FRG/U.S. Cooperative Fuel Performance Program and initiate in-pile tests to determine fuel performance under expected operating conditions; and issue several Technology Development Plans that analyze fuel and fission product behavior, graphite properties, and metals properties.

HIGH TEMPERATURE GAS REACTORS

Mr. Bevill. How much exactly is requested in FY 1987 for HTGR?

Mr. Vaughan. In FY 1987, a total of $5.3 million is requested for the HTGR--$4.0 million for design and licensing activities and $1.3 million for technology.

Mr. Bevill. What will the FY 1987 funds be used for?

Mr. Vaughan. These funds will be used to continue advanced HTGR design development and trade-off studies, supporting R&D, and interactions with NRC. These FY 1987 efforts will include completion of conceptual design of HTGR passive safety features; continuation of the design of critical nuclear systems and balance-of-plant components and testing of essential features of those components; updating of R&D requirements based on additional design work; an assessment of advanced HTGR application to defense needs; and continued interactions with international HTGR programs.

Mr. Bevill. What percent of a reference small HTGR concept design will be completed by the end of FY 1986? FY 1987?

Mr. Vaughan. In FY 1986 and FY 1987, the program will be in the conceptual design phase, and approximately 50 percent of the conceptual design will be completed at the end of FY 1986. The requested FY 1987 funds will enable the program to achieve 55 to 60 percent completion of the conceptual design by the end of the fiscal year.

Mr. Bevill. When is it planned that detailed design of the small HTGR will begin and be completed?

Mr. Vaughan. The current program will move forward with R&D activities to provide solutions to technical issues, to incorporate such advancements in the design concepts, and to obtain acceptance of the design by NRC such that uncertainties will be reduced to the level where private sector interest would be justified, and to support a concept evaluation as described in our draft Strategic Plan for the Civilian Reactor Development Program. At that point, a detailed design could begin, assuming that such action is supported by the results of the evaluation. We estimate about 3 years will be required to complete a detailed design.

Mr. Bevill. How much will it cost?

Mr. Vaughan. We estimate that the total detailed design costs will be approximately $300 million.

Mr. Bevill. Is construction of a demonstration advanced HTGR planned. If not, what are the goals of the program?

Mr. Vaughan. Prior to completion of the R&D evaluation and design activities discussed in our draft Strategic Plan and in the absence of an acceptable private sector initiative, the Department does not plan to construct a demonstration advanced HTGR. The goal of the program is to develop HTGR's for a broad range of future market applications by capitalizing on the passive safety and high temperature characteristics of these plants to produce a lower cost, passively safe, acceptable plant.

The goal of the program is to move forward with the R&D activities to provide solutions to technical issues in support of the reactor concept evaluation, to incorporate such advancements in the design, and to obtain acceptance of the design by NRC such that uncertainties will be reduced to the level where a private sector commitment would be justified.

Mr. Bevill. How much would such a demonstration cost and how long would it take?

Mr. Vaughan. We estimate that such a demonstration would cost $600 to $900 million in 1985 dollars, depending on the size and details of the system, with design requiring approximately 3 years, construction approximately 4 years, and operational testing 2 years.

NUCLEAR STRATEGIC PLAN

Mr. Bevill. DOE's original Nuclear Strategic Plan, issued in draft form last November for ERAB review, appeared to be responsive to the Subcommittee's strong interest in establishing a focused, civilian project oriented advanced reactor program at DOE. What is the basis for the drastic change in DOE policy and planning reflected in the FY 1987 budget proposals--namely "phase down commercial advanced reactor development and redirect programs to determine applicability to emerging military/space needs"?

Mr. Vaughan. We do not feel that the FY 1987 budget request reflects a drastic change in DOE policy or planning for our reactor development programs. The Department has provided R&D support for both the defense and civilian nuclear energy areas for decades and both areas will continue to be served by the proposed programs. The priority of military programs has not changed; programs have expanded and moved ahead as planned while the overall funding stringencies have tightened. It is our intent to integrate and coordinate those efforts to the maximum extent so as to minimize the overall cost.

The essence of DOE's draft Strategic Plan for Civilian Reactor Development is to establish an agenda of requisite actions and tasks to develop advanced reactor systems that can be acceptable and competitive in a future market. While the pace of the program to fulfill that agenda must be adjusted to accommodate the priorities and budget constraints, it is the Department's intent to continue to operate our unique liquid metal reactor

test facilities and conduct the R&D leading to advanced civilian reactor systems at an appropriate time in the future. A revised Strategic Plan, based on consideration of comments received from the Panel, Congress and others will be valuable in guiding and focusing DOE's civilian reactor development programs, in helping assure complementary efforts by the private and public sectors, and in maintaining goals and objectives to ensure effective utilization of funds.

The approach to which we are proposing may well prove to be a more cost effective one. It is not clear that the phase down of more detailed civilian converter design activities will indeed slow the ultimate introduction of an advanced converter reactor into the market. Many of the key technological and regulatory advances that must be made to permit economic advanced designs have been identified and the necessary technological investigations are proceeding as are the interactions with NRC and guiding conceptual design activities and economic evaluations.

The advanced civilian reactor development program has embarked on a course destined to develop advanced nuclear systems that meet market demands. Our rate of progress on that course must be tempered by fiscal constraint. However, we have made important progress and our resolve to meet our objectives is undiminished.

PRIVATE SECTOR INVOLVEMENT

Mr. Bevill. Does DOE seek to foster a private-sector project initiative and significant cost/risk sharing and if so, how?

Mr. Vaughan. The Department believes that a private-sector project initiative is a prerequisite for any construction project and would give consideration to meaningful proposals. DOE has encouraged the advanced plant designers to seek out private sector support for their concepts and to develop industry teams and cost-sharing proposals that place the majority of responsibility on the team members and assume a technical and financial role for the Government that is consistent with national policy. These and other factors will be considered in the evaluation of concepts that are candidates for further, enhanced development.

A number of conditions must be met to cause a project to happen. First, R&D must be successfully completed to substantiate that the key characteristics--low cost, passive safety, and licensability--are confidently in hand. Second, a design concept must be developed that reflects the results of the R&D and produces a high confidence product that is competitive with other electrical generating systems available at that time and that has gained regulatory, public, utility, and financial market acceptability. This will require an active dialogue between the Government and private industry to communicate results of R&D and design progress and to allow the Government to assess the degree of increasing private sector interests as the R&D progresses.

HIGH TEMPERATURE GAS REACTOR

Mr. Bevill. Why was the HTGR budget reduction proposed for FY 1987 so much greater (80 percent) than the ALWR (no reduction) or the LMR (25 percent reduction in civilian, but increased--probably--when space/military applications are considered)?

Mr. Vaughan. The reductions reflect budgetary constraints and a realistic assessment of the R&D needs and potential market timing of the various technologies. Each of these programs is paced to progress in an integrated manner toward the concept evaluation discussed in our draft Strategic Plan for the Civilian Reactor Development Program. We believe that the ALWR offers the best near-term opportunity for restoration of the nuclear option. Advancements can be made both from a technical and an institutional viewpoint. Success in the institutional area will be of benefit not only to LWR's but also to eventual deployment of advanced LMR or HTGR reactors.

Thus we believe that appropriate funding has been allocated to each reactor concept. The goal is to develop a product that is superior to what is on the market and that will attract private financing. We are confident that we will achieve that goal.

Mr. Bevill. Are the project development activities being pursued by the private sector participants in the HTGR program deemed incredible or are they a threat to DOE's unstated policy preference for a "paper study approach to reactor development?" (Reference Joint Statement for Project Activities)

Mr. Vaughan. The project development activities are reasonable and reflect project organization and approaches that have been the subject of considerable discussion. Given a proper amount of cost sharing and financial commitments by the private sector, the plans could serve as a basis for initiating discussions for DOE funding.

The DOE draft Strategic Plan calls for resolving key technical issues, evaluating candidate concepts, performing requisite additional design and NRC interactions before committing to a demonstration project. The DOE HTGR program is currently focused on the development of a marketable HTGR design that will be competitive with other contemporary sources of power production and one that will be acceptable to both future plant owners and the public. Development activities being pursued include plant design and analysis, licensing interactions with NRC to assure licensability within reasonable schedule and cost constraints, and the development of test hardware and associated testing activities to assure plant design feasibility and success. Hardware development and testing activities include fuel kernel and coated particle processing with methods development, fuel rod irradiation testing, graphite component development

and testing, natural circulation air cooling system, high temperature alloy testing, and helium gas circulator development.

The program described above is aimed at resolution of all key technical issues, the incorporation of R&D results into the concepts so that they may be properly evaluated before progressing into detailed design.

RTG PROGRAM

Mr. Bevill. For each component of the RTG program, provide a description, contractor, FY 1985, 1986, and 1987 costs, total cost and completion date.

Mr. Vaughan. The RTG program is comprised of three major project activities--Galileo/Ulysses, Modular Isotope Thermoelectric Generator, and Special Applications. The program also includes fuels production and fabrication, technical support, and safety and launch support activities. I would be pleased to provide a more detailed answer to your question as an insert in the record.

Mr. Bevill. Would DOE welcome a cost-sharing proposal from the private sector participants in the HTGR Program to get on with a Modular HTGR Demonstration Project? If not, why not?

Mr. Vaughan. Yes, DOE would consider a cost-sharing proposal from the private sector. The direction of the program is to move forward with the R&D activities to provide solutions to technical issues, to support the concept evaluation, and to obtain acceptance of the design by the NRC such that uncertainties will be reduced to the level where the private sector interest would be justified. We believe that the private sector should have the lead responsibility for financing, detailed design, construction, and plant operation.

LIQUID METAL CONVERTER REACTOR

Mr. Bevill. How much of the LMR budget request for FY 1987 is for support of the laboratory structure?

Mr. Vaughan. The FY 1987 budget request for LMR activities supports specific tasks that focus on key economic, technical and institutional issues that have been identified as the result of conceptual design work successfully completed. Each of these tasks is conducted at the laboratory or contractor best suited to perform the work. Thus, none of our requested funding is used solely to support the laboratory structure. Approximately $31 million of the FY 1987 LMR budget request supports national laboratory work.

Mr. Bevill. What vendors were selected and what activities will each engage in in FY 1986 and 1987?

Mr. Vaughan. Two LMR lead vendors were selected for FY 1984 and will continue into FY 1987--General Electric for the PRISM concept development and Rockwell International for the SAFR concept development. The activities to be pursued by General Electric in FY 1987 include continued concept development and trade-off studies, updates of capital and busbar cost estimates, fuel cycle assessments, continuing licensing interactions with NRC, including preparation of an updated Preliminary Safety Information Document, an evaluation of the PRISM design for defense applications, and updated plant arrangement drawings, design descriptions, and R&D needs.

The activities to be pursued by Rockwell International in FY 1987 include continued concept development and trade-off studies, updated plant performance analyses based on test results, continued interactions with NRC, including preparation of an updated Preliminary Safety Information Document, core design refinements, in-service inspection equipment design, updated plans and cost and schedule estimates, fuel cycle development, transient and seismic analysis, an evaluation of the SAFR concept for defense applications, and updated plant arrangement drawings, systems design descriptions, and R&D needs.

Mr. Bevill. How much money will each vendor receive in FY 1986 and 1987?

Mr. Vaughan. In FY 1986, the advanced LMR concept designers will receive a total of $13,927,000--$8,848,000 for the GE PRISM concept and $5,079,000 for the Rockwell SAFR concept.

In FY 1987, it is presently planned that each contractor will receive $3 million each. This is subject to change based upon the final FY 1987 appropriations.

Mr. Bevill. What, if any, cost-sharing requirements were imposed on these vendors?

Mr. Vaughan. The advanced LMR concept development contractors, as part of their initial proposals, were evaluated on their willingness to share costs. The successful bidders, General Electric and Rockwell International, agreed to provide private funding for commercialization studies to support their designs. The General Electric cost-share contribution is $500,000 per year and the Rockwell International cost-share contribution is $400,000 per year. These contributions take into account indirect costs and overhead that the contractor would have otherwise charged DOE. In addition, each of these contracts have a no-fee arrangement.

Mr. Bevill. What hardware will be developed and fabricated with FY 1986 and 1987 funds?

Mr. Vaughan. Hardware will be developed and fabricated in FY 1986 and 1987 to conduct key features tests that will support advanced designs. At the Energy Technology Engineering Center, installation of a fiber optic signal transfer system for advanced instrumentation and control will be completed and testing will be performed; a robotic inspection system for inherently safe heat removal systems will be prepared for testing; design and procurement will be completed for large diameter reactor seals and testing will be initiated; and efforts will be initiated for demonstration of a jet pump for a self-actuating reactor safety system. Scale model testing of advanced heat removal systems will be conducted.

Test article installation and facility improvements will be completed in preparation for 70 megawatt helical coil tube model steam generator testing and checkout, and initial testing will be performed. This effort will include final preparations for leak detection and in-service inspection hardware and techniques. In the Thermal Transient Facility at ETEC, testing of piping sections and fittings will be conducted to confirm mechanical, thermal, and seismic design bases. A high temperature, space environmental test facility will be activated using existing hardware, for use in acceptance testing of key components of the SP-100 Ground Engineering System prior to their integration in the system test at the Hanford Engineering Development Laboratory.

At HEDL, these hardware programs include fabrication and testing of prototypic materials and oxide and metal fuels for long life LMR cores; testing of fuels for the SP-100 defense reactor; fabrication and testing of man-machine integration systems for automated plant refueling and on-line diagnosis of potential fuel pin failures; preparations for selection and testing of advanced instrumentation, controls, and computer systems that utilize artificial intelligence methods and techniques; and installation of Secure Automated Fabrication line equipment in the Fuel and Materials Examination Facility, as well as engineering and field testing of an inservice-inspection unit for LMR pipe welds. The FFTF will also demonstrate loss-of-flow without scram capability at increasing power levels.

At the ANL-West EBR-II facility, hardware programs include testing of breached oxide fuel elements under off-normal conditions, fabrication and irradiation testing of advanced metal fuels, testing of a gimbaled bellows expansion joint, testing of advanced instrumentation, and irradiation of fuel, cladding, and sheathed insulators for the SP-100 defense reactor. Planning efforts will be completed for installation and testing of a reactor diagnostic system. Also, at the ANL-West site, we will conduct transient testing of metal and long life oxide fuels in the TREAT Facility and do proof-of-principle testing for an SDI concept. The TREAT Upgrade modification will be completed.

Mr. Revill. The justification material states that: "The TMI activities are implemented in accordance with a MOU signed by DOE, NRC, EPRI, and GPU Nuclear Corporation." Under the reduced FY 1982 budget request will DOE be in compliance with the terms and conditions of that MOU?

Mr. Vaughan. DOE will be in full compliance with the terms and conditions of the DOE/NRC/EPRI/GPU Nuclear Corporation Memorandum of Understanding.

Mr. Bevill. Provide for the record the terms and conditions of the original MOU and the ways in which DOE has and has not complied with them and will in FY 1987.

Mr. Vaughan. The Memorandum of Understanding provides for cooperation in a number of areas and for sharing and distribution of R&D results. Specific areas include damage assessment, severe accident evaluation, decontamination, evaluation of instrumentation and control performance, fission product behavior, waste processing and disposal, and defueling and core transportation. DOE intends to complete its program in all specified areas and be in full compliance with the MOU.

BYPRODUCTS UTILIZATION

Mr. Bevill. Discuss the Department's efforts in food irradiation, where the program is being conducted and what the objectives are.

Mr. Vaughan. In the FY 1986 appropriations to the Department, the Congress provided $5,000,000 and directed the Department to initiate a civilian byproducts utilization program with emphasis on food irradiation applications. Cooperation with States, other Federal agencies, and private sector organizations is being pursued in order to promote acceptance of the technology in the marketplace. Based on guidance provided by the Congress, the program is proceeding with plans for regionally-based commodity irradiation facilities in six States; Oklahoma, Hawaii, Iowa, Florida, California, and Washington. The bases for selecting these States are their proximity to major agricultural commodity production and processing centers and the benefits to be derived by their use for food irradiation processing. The program also will focus on developing an adequate U.S. based supply of irradiation sources for commodity irradiations. DOE operations offices at Albuquerque, NM, and Richland, WA, share the lead for implementing the program.

Mr. Bevill. Summarize the history of food irradiation research and the results of it, particularly as it relates to health safety.

Mr. Vaughan. The first U.S. patent application for food preservation through irradiation was filed in 1905. The current value of radiation technologies to improve food quality is recognized worldwide. Twenty-two countries have approved irradiation use on some 30 foods with no evidence of adverse health effects. The National Bureau of Standards and National Academy of Sciences studied food irradiation in the early 1960's and concluded that consumers would not be exposed to radiation by eating properly irradiated food because the process would not induce radioactive changes in the food. Health safety with respect to irradiated foods is properly the regulatory responsibility of the Food and Drug Administration and the U.S. Department of Agriculture.

Mr. Bevill. Why did DOE split the management of the six irradiation projects between two field offices?

Mr. Vaughan. Management of the six irradiation projects was split between two field offices to obtain the balance of responsibilities for six different regions of the country and to enhance the technical capabilities that were needed to carry out this program.

Mr. Bevill. How much will it cost to complete these six projects?

Mr. Vaughan. Each regional agricultural commodity irradiation project is estimated to cost $4 to 5 million including technical support, construction and initial operations. No funding is being requested by the Department in FY 1987 and we do not plan to do so beyond FY 1987. The projects in California and Iowa will continue in FY 1987 using available prior year funding. For future years, we will seek to assist sponsors in seeking State or private sector funding for completion of the commodity irradiation projects.

BREEDER COMPONENT TECHNOLOGY

Mr. Bevill. What are the current goals of the breeder program and how is each component related to these goals?

Mr. Vaughan. The current goal of the breeder is to extend Liquid Metal Reactor technology to its ultimate use in an inexhaustible fuel supply for electric power generation. The current availability of ample supplies of diverse fuels has resulted in a relaxation in the need and timing for breeder cores. It is important to understand that distinctions between a breeder and a liquid metal cooled converter reactor have to do with the fuel and fuel cycle. Otherwise, the powerplants can be very similar in equipment, configuration, and operation.

The overall goals of the breeder program, therefore, emphasize those technologies necessary to develop the breeder as an inexhaustible fuel supply consistent with the need to achieve inherent safety, reduced generating costs, diversion resistant fuel cycle, and environmental advantages compared to alternatives.

Ongoing efforts include advanced cladding and advanced fuels to achieve fuel life extension, the development of remotely operated fuel fabrication and reprocessing technologies with built-in safeguards and accountability capabilities, core physics development to assure inherent safety in the use of these fuels, and advances in plant component

technology, particularly smart sensors, diagnostics, on line monitoring, and operator simplification techniques.

Recent work suggests that the breeder may enable the recovery and recycle of transuranic waste into the reactor at little or no added cost to the fuel cycle or reactor performance. If this succeeds, the result could be a dramatic reduction in the half-life of high level radioactive waste, and the potential for important benefits in terminal waste processing and isolation technology. Although it is too early to guarantee that these results will succeed, the prospect illustrates the environmental benefits of pursuing this technology.

An important element of the breeder program is our effort in international cooperation. For example, cooperative programs in the fuel cycle area exist with the United Kingdom, France, and Japan, and one is being negotiated with the Federal Republic of Germany--these for the most part are focused on remote systems technology exchange. Discussions which started over a year ago with Japan on a broadened exchange are continuing, and a meeting is scheduled this month to further explore options and develop recommendations. DOE supports this process and at this point there appears to be considerable interest on the part of Power Reactor and Nuclear Fuel Development Corporation in joint funding such a program. In addition, new collaborative efforts with Japan will be undertaken in the areas of advanced reactor designs, critical experiments in the Zero Power Plutonium Reactor, and a 2-year extension in the Run-Beyond-Clad Breach program being conducted in the Experimental Breeder Reactor II.

TEST FACILITIES

Mr. Bevill. Provide a table showing all facilities used in support of the nuclear reactor research program. What is done at each, how many people are employed in each, what the annual operating costs are in 1985, 1986, 1987, and what experiments or other work is planned for each facility in 1986 and 1987?

Mr. Vaughan. I will be pleased to provide this information for the record.

(The information follows:)

NUCLEAR ENERGY PROGRAM MAJOR FACILITIES

The nuclear energy program's major facilities, which are funded under the facilities element of the budget, are located at the Hanford Engineering Development Laboratory (HEDL) near Richland, Washington, the Argonne National Laboratory facility near Idaho Falls, Idaho (ANL-West), and the Energy Technology Engineering Center (ETEC) at Santa Susana, California. The facilities located at these sites and the major activities conducted are as follows:

- Hanford Engineering Development Laboratory

  The major facilities at HEDL supporting the nuclear research program, and other DOE and government programs are the Fast Flux Test Facility (FFTF) complex that includes the Interim Examination Cell and the Maintenance and Storage Facility, the Fuels and Materials Examination Facility (FMEF), and the Secure Automated Fabrication (SAF) line. Principal supporting facilities at HEDL are located in the 300 Area site and provide test pin fabrication capability, hot cells, and chemistry and metallurgical laboratories. The major activities carried out at each of these facilities are as follows:

  FFTF--irradiation of prototypical sized fuels and materials; inherent safety testing to determine reactivity feedback contributions to passive safe shutdown margins for mixed-oxide fuel including those for reactor loss-of-flow without scram; feasibility demonstration of producing Cobalt 60 and Gadolinium 153 isotopes for medical uses; irradiation of candidate fuels for the defense SP-100 program; fabrication and irradiation of fuel and blanket test assemblies for joint program with the Power Reactor and Nuclear Fuel Development Corporation (PNC) of Japan; test demonstration of a 3-year long-life mixed-oxide core; irradiation of International fusion program material specimens; and verification of operational reliability of mixed oxide reactor and core systems of Liquid Metal Reactors (LMR's).

  FMEF/SAF--highly automated fabrication of mixed oxide fuel, and assembly of fuel pins.

- Argonne National Laboratory (ANL)-West

  The major facilities at ANL-West supporting the nuclear research program, and other DOE and government programs are the Experimental Breeder Reactor (EBR)-II, the Transient Reactor Test Facility (TREAT), the Zero Power Plutonium Reactor (ZPPR), and the Hot Fuel Examination Facility (HFEF). The major activities carried out at each of these facilities are as follows:

EBR-II--irradiation of both advanced converter and defense reactor (SP-100) fuels and materials in a fast flux sodium environment to determine their performance; irradiation of breached oxide fuel under joint program with Japan, to determine its behavior under normal and off-normal operating conditions and its effect on the reactor primary system; irradiation of metal fuels to demonstrate their behavior and burnup limit; inherent safety testing to determine reactivity feedback contributions to passive safe shutdown margins for reactors, including tests for loss-of-flow, loss-of-heat-sink and control rod withdrawal, without scram; and verification of operational reliability of reactor and core systems of LMR's under plant lifetime exceeding 22 years.

ZPPR--critical measurements to check the accuracy of methods of calculations used by reactor designers and to verify core designs.

TREAT--testing of reactor fuels under conditions simulating various types of extreme off-normal conditions in order to determine fuel performance, reliability and safety margins.

HFEF--assembly, disassembly, and examination of fuels and materials irradiated in the FFTF, EBR-II, and TREAT.

o Energy Technology Engineering Center

The major facilities at ETEC supporting the nuclear research program, and other DOE and government programs are the Sodium Components Test Facility (SCTI), the Thermal Transient Facility (TTF), and a variety of test rigs and loops. The major activities carried out at each of these facilities are:

SCTI--performance and endurance testing of sodium steam generators and heat exchangers, and preparation for integration with the Power Pak cogeneration addition at the ETEC.

TTF--non-sodium, thermal, seismic, and mechanical stress testing of piping systems, fittings, and components to failure.

Other ETEC Facilities--testing small components, instruments and small models of components and systems at prototypical conditions.

NUCLEAR ENERGY PROGRAM MAJOR FACILITIES BUDGET AND STAFFING LEVELS
($ in Millions)

	FY-1985	FY-1986	FY-1987 2/	March 1986 Staffing Level
HEDL				
FFTF/IEM/MASF	$46.5	$44.0	$43.0	
FMEF/SAF 1/	10.0	8.9	17.5	
300 Area (Test pin fabrication hot cells; chemical & metallurgical labs	11.0	10.4	6.6	
HEDL Facilities Budget	$67.5	$63.3	$67.1	950
ANL-West				
EBR-II	25.8	28.5	26.0	
HFEF	12.4	13.6	11.8	
ZPPR	2.7	6.0	3.0	
TREAT	3.2	3.4	3.5	
ANL-W Facilities Budget	$44.1	$51.5	$44.3	700
ETEC				
SCTI	9.6	6.3	5.6	
TTF	1.8	1.2	1.0	
Other Facilities	8.3	4.1	2.5	
ETEC Facilities Budget	$19.7	$11.6	$9.1	195

FOOTNOTE:

1/ Hot Cell activities funded under Fuels and Performance budget element in FY 1985 and FY 1986.

2/ Allocation of FY 1987 funds in preliminary and is subject to change as FY 1987 requirements are further defined and based upon final FY 1987 appropriations.

NUCLEAR ENERGY PROGRAM MAJOR FACILITIES
FY 1986 ACTIVITIES

HEDL

- o FFTF
  - Loss-of-flow without scram tests at less than 50 percent full power demonstrating inherent safety of LMR's.
  - Preparation and testing of man-machine integration systems for automated plant refueling and for on-line diagnosis of potential fuel pin failures.

- o FMEF/SAF
  - Installation of Secure Automated Fabrication (SAF) line equipment in the Fuels and Materials Examination Facility (FMEF).

- o 300 Area
  - Fabrication of 3-year oxide fuel system for core demonstration experiment.
  - Fabrication of Cobalt 60 and Gadolinium 153 production feasibility test articles for irradiation in FFTF.
  - Assembly of prototypical metal fuel assembly test for irradiation in FFTF.

ANL-West

- o EBR-II
  - Loss-of-flow without scram tests demonstrating inherent safety margin of metal fueled LMR's.
  - Loss-of-heat sink without scram tests demonstrating inherent safety of LMRs.
  - Testing of breached oxide fuel elements under off-normal reactor conditions in cooperative program with the Japanese.
  - Irradiation of metal fuel of varying uranium-plutonium-zirconium compositions to several levels of burnup.
  - Testing of gimbaled bellows expansion joint.
  - Demonstration of continued sustained high plant reliability.
  - Analysis of performance and maintainability of components and systems in service over 22 years.
  - Irradiation of fuel cladding and sheathed insulators for SP-100.

- o TREAT
  - Safety verification testing of metal fuel.
  - Transient tests on irradiated long-life mixed oxide fuel to verify margin of safety.
  - Proof-of-principle testing in support of SDI.
  - Fabrication of fuel assemblies for TREAT Upgrade.

ANL-West (continued):

- IFFR
  - Measurements for plutonium equilibrium core and uranium startup core for metal fuel.
  - Large-core axial heterogeneous criticals under joint US/Japan program.

- HFEF
  - Assembly, disassembly, and examinations of FFTF, EBR-II, and TREAT test articles.

ETEC

- SCTI
  - Test article installation and facility improvements in preparation for 70 megawatt (MW) helical coil tube model steam generator test program.
  - Checkout and initial operation of the 70 MW helical coil tube model steam generator and of the modified test facility.
  - Selection of private sector financing and construction firm and installation of "Power Pak" cogeneration equipment to achieve low cost endurance testing of steam generator and other plant components.
  - Final preparations of leak detection and in-service inspection hardware and techniques prior to operation of helical coil steam generator.
  - Exploration of Japan co-sponsorship of ETEC test program on double wall tube 70 MW model steam generator now in fabrication.

- TTF
  - Testing of piping sections including fittings to confirm mechanical, thermal, and seismic design bases for safe, economic reactor plant configurations.

- Other ETEC Facilities
  - Design and fabrication of robotic inspection system for inherently safe reactor emergency heat removal system, and preparation for test.
  - Design, procurement, and start of testing on large diameter coolo for hermetically sealed advanced reactor concept.
  - Test programs on models of inherently safe emergency heat removal systems for advanced reactors.

[illegible]
[illegible]

[illegible]

- [illegible]
  - Loop-of-flow without access testing for 30 percent full power and greater.
  - Irradiation of EF-1[illegible] fuel test article.
  - Irradiation of initial lobule 60 and [illegible]mm [illegible] production feasibility test articles.
  - Flow demonstration of automation integration systems for automated plant refueling and for on-line diagnosis of potential fuel pin failures.
  - Irradiation of 3-rower oxide fuel system and initial prototypical metal fuel assembly test.

- [illegible] area
  - Fabrication of fuel and blanket test assemblies for irradiation in [illegible] under the [illegible] program with [illegible] of Japan.
  - Fabrication of International Fusion Program-sponsored open test article for irradiation in [illegible].

- [illegible]/test
  - Integrated operational check-out of [illegible] process systems.

[illegible]

- [illegible]
  - Testing to demonstrate [illegible] capability to inherently accommodate a control rod withdrawal event without any action of engineered safety systems.
  - Irradiation of metal fuel assemblies.
  - Conduct of initial irradiation tests for [illegible] program.
  - Testing of fuel, cladding and shielded insulator materials for delinkmgeneric and potential chemically reactor systems.
  - Conduct of joint program with [illegible] on behavior of breached oxide fuel under off-normal reactor conditions.
  - Integration of reactor control functions into a central "intelligent" control station, verify automated computerized reactor control for startup, operation, and fuel handling.
  - Run-beyond-clad-breach tests on uranium-plutonium-zirconium metal fuel.

ANL-West (continued):

- TREAT
  - Metal fuel safety verification testing to confirm expansion of fuel into fission gas chamber.
  - Proof-of-principle tests in support of EBR.
  - Tests to verify margin of safety for long-life mixed oxide fuel for FFTF.
  - TREAT Upgrade Project modifications.

- ZPPR
  - Large mixed oxide core critical measurements in cooperation with Japan.
  - Critical measurements on two small innovative design uranium cores.

- HFEF
  - Post-Irradiation Examination (PIE) of FFTF fuel assemblies.
  - PIE of experiments irradiated in EBR-II for the SP-100, metal fuel, and Japanese programs.
  - PIE on TREAT experiments for metal and oxide fuel.

STEC

- SCTI
  - Tie-in of privately financed "Power Pak" cogeneration equipment with existing 70 megawatt Sodium Components Test Installation; and preparation for steam generator endurance testing.

- TTF
  - Failure tests of large pipe loop model.

- Other STEC Facilities
  - Testing of robotic inspection system for inherently safe emergency heat removal system for advanced reactor.
  - Testing of large diameter reactor seals for hermetically sealed advanced reactor.
  - Testing of a jet pump for a self-actuating reactor safety system.
  - Conduct of test programs on scale models of inherently safe emergency heat removal systems for advanced reactors.
  - Conduct of test programs for selected advanced concept components such as pumps and heat exchangers.
  - Activation of low cost, high temperature, space environment test facility for acceptance testing of key components of the SP-100 Ground Engineering System (such as electromagnetic pumps, intermediate heat exchanger, and reactor simulator) prior to their integration in the system test at HSTF.

Mr. Bevill. For each facility listed above, discuss the consequences to the program of closing the facility and identify where else in the country similar research is or could be conducted.

Mr. Vaughan. The nuclear energy program's major facilities provide many useful unique testing capabilities which are essential to the civilian and space nuclear research and development programs. The Office of Nuclear Energy is currently performing a facility review with a key objective being to assess means to optimize utilization of our facilities in meeting program requirements. The integration of program requirements, facility capabilities, and alternatives will be addressed. That review will be completed later this spring. The FY 1987 budget for facilities supports continued operation of our major facilities, including those at ANL, HEDL and ETEC, to serve program needs.

Mr. Bevill. What will be done with the funds requested for FY 87?

Mr. Vaughan. The scope of activities to be conducted by the Consolidated Fuel Reprocessing Program will depend to a significant extent on the degree of joint collaboration with foreign programs and their contribution of funding support. Currently, meetings are underway with the Power Reactor and Nuclear Fuel Development Corporation of Japan to develop a cost-sharing arrangement. If such efforts are successful such that the combined funding would be in the range of $10 million, work could continue at a level to enable the U.S. to sustain a viable nuclear fuel cycle research and development effort. With these funds, we would continue the development of extremely reliable components which are smaller and more efficient, and specially designed for remote operations and remote maintenance. For reprocessing or other environments where hands-on contact is not practicable, the components would be mounted in modules or racks which are replaceable in whole or part, or adjusted or repaired in-place using electromechanical servomanipulators. The manipulators would be man-controlled from a remote operating station, using closed-circuit TV. Principal development and testing activities in FY 1987 will be directed to small centrifugal contactors that replace large pulse columns for solvent extraction chemistry used in reprocessing will be installed in the Integrated Equipment Test facility in FY 1986. Reliability and remote maintenance testing will be conducted in FY 1987. In addition, an Environmental Test Chamber to experiment with low-flow ventilation in

process cells will be completed and testing will be initiated in FY 1987. The Advanced Servomanipulator and Advanced Integrated Maintenance System will be completed in FY 1986 and testing will be initiated in FY 1987.

If efforts to establish a collaborative effort do not produce a significant level of funding support, FY 1987 activities will be limited to continued development of remote maintenance and operation technology to reduce maintenance time and operations costs, and to improve safety conditions.

Mr. Bevill. What equipment will be purchased in FY 1987?

Mr. Vaughan. There are no planned purchases of equipment with FY 1987 funds for fuel cycle activities. The requested equipment funding of $2.8 million is for facility activities at the Hanford Engineering Development Laboratory, Argonne National Laboratory-West, and Energy Technology Engineering Center sites to procure special test hardware and equipment required for the experiments.

Mr. Bevill. Provide a list of all planned construction in FY 1987.

Mr. Vaughan. There is no planned construction for fuel cycle activities in FY 1987. For FY 1987, we have requested $3.8 million for construction projects at our facilities. We have allocated $0.6 million for the Argonne National Laboratory-West physical security upgrades; $2.2 million for alternations, additions, and modifications required at the Energy Technology Engineering Center and the Hanford Engineering Development Laboratory to maintain the sites and facilities in a condition to support program activities; and $1.0 million for modifications to the Experimental Breeder Reactor II and the Fast Flux Test Facility to help maintain the operating efficiency, capability, and reliability of these reactors.

SPACE AND ADVANCED REACTOR SYSTEMS

Mr. Bevill. What are the "commercial advanced converter conceptual evaluations" referred to in the justification material?

Mr. Vaughan. The commercial advanced converter conceptual evaluations mentioned in the FY 1987 Congressional Budget Request refers to the advanced LMR and HTGR concepts currently under development and the evaluations that were planned for narrowing down those and other potential candidates and identifying one for enhanced development and possible demonstration. A thorough discussion of this evaluation is contained in our draft Strategic Plan for the Civilian Reactor Development Program.

Mr. Bevill. What is the rationale for phasing them down?

Mr. Vaughan. Two factors are at work. One is the need to focus on key technical issues identified to date so that solutions can be incorporated into the conceptual designs. With continued funding, it is appropriate to focus on technology issues the resolution of which will end in achieving the goals of reduced costs, passive safety, and licensing acceptability. The second factor is the increase in near term needs of space and defense energy applications--for example, the emergence of the Strategic Defense Initiative and its multiple concepts for which advanced nuclear power technology is frequently the most advantageous choice to meet power source needs. In the face of the urgent need to reduce Government outlays, DOE has recommended an adjustment in the pace of the civilian reactor development program in order to meet growing SDI needs rather than proposing the buildup of a new, separate and costly program capability unique to SDI applications.

The Department believes that providing support for this new activity through utilization of its facilities, technology, and manpower for future defense applications will not detract from its continued commitment to the development of advanced reactors for commercial applications. Further, we believe that the activities can be complementary, and that technology development work can be managed so that benefits accrue to both defense and civilian programs. We are still fully committed to the need for advanced reactors, and the Department is confident that future market demands for advanced reactor systems will be met.

DOE FUNDING
GALILEO/ULYSSES
($ in Millions)

	FY 1985	FY 1986	FY 1987	TEC	COMPLETION DATE
Development, fabrication, and delivery of RTG's to Kennedy Space Center. The RTG is of the GPHS design with approximately 290 watts electrical output per RTG. Four flights RTGs have been delivered.					
General Electric	2.8	2.2	1.0	70.6*	9/88
Fuels Production/Fabrication 1/					
Mound	1.1	0	0		
Oak Ridge National Lab.	0.8	0	0		
Savannah River Plant	0.7	0	0		
Technical Support 2/					
Sandia	0	0.4	0.3		
Fairchild	0.7	0.7	0.6		
Safety & Launch Support 3/					
Los Alamos National Lab.	2.7	1.6	1.3		
Naval Ocean System Center	0.1	0.1	0.1		
NUS Corporation	0.5	0.3	0.3		
Applied Physics Lab.	0.5	0.5	0.4		
SUBTOTAL	9.9	5.8	4.0		

* Plus NASA reimbursable funds of $43.0 million for General Electric and general administration (e.g., fuels payments), and related support costs of $14.0 million for a combined total of $127.0 million.

DOE FUNDING
MODULAR ISOTOPE THERMOELECTRIC GENERATOR
($ in Millions)

	FY 1985	FY 1986	FY 1987	TEC	COMPLETION DATE
Design and development of ground demonstration unit. This is an advanced modular RTG for future civilian or military space missions. Output is flexible depending upon power and mission requirements.					
General Electric	4.5	2.3	6.2	16.2 (FY 83-87)	9/87
Fuels Production/Fabrication 1/					
Mound	1.0	3.7	3.5		
Oak Ridge National Lab.	0.2	0.8	1.3		
Savannah River Plant	0.3	1.2	1.1		
Technical Support 2/					
Battelle Memorial Institute	0.2	0.2	0.2		
Ames	0.5	0.4	0.4		
Fairchild	0.2	0.3	0.3		
General Electric	0.8	0.7	0.8		
Safety & Launch Support 3/					
Los Alamos National Lab.	0.9	0.5	0.4		
NUS Corporation	0.1	0.1	0.1		
Applied Physics Lab.	0.1	0.1	0.1		
SUBTOTAL	8.8	10.3	14.4		

DOE FUNDING
SPECIAL APPLICATIONS
($ in Millions)

	FY 1985	FY 1986	FY 1987	TEC	COMPLETION DATE
Design and development of ground demonstration unit. These are smaller terrestrial units with power in the range of 3-5 watts.					
Teledyne	1.2	0.9	1.2	3.3	Continuing
Fuels Production/Fabrication 1/					
Mound	0	0.1	1.8		
Oak Ridge National Lab.	0	0.1	0.1		
Savannah River Plant	1.0	0.1	0.2		
SUBTOTAL	1.2	1.2	3.3		
The following contractors perform ongoing activities in support of all RTG projects:					
Fuels Production/Fabrication 1/					
Mound	5.0	0.4	0.3		
Oak Ridge National Lab.	0.4	0.3	0.2		
Savannah River Plant	1.0	0.3	1.3		
Technical Support 2/					
SBIR	0	2.2	1.9		
SUBTOTAL	6.4	2.2	1.9		
TOTAL PROGRAM	26.3	19.5	23.6		

1/ This entails work to produce and encapsulate the Pu 238 radioisotope material in a form that is suitable for use within a Nuclear Power System. Work is conducted at the Miamisburg, Ohio, Mound Facility; the Oak Ridge

(Tennessee) National Laboratory; and the Savannah River Plant near Aiken, South Carolina, operated by E. I. duPont de Nemours and Company.

2/ This entails various material and analytical, evaluative/safety activities related to all the RTG programs, and is conducted at a number of widely dispersed laboratories and offsite contractors.

3/ This entails similar analytical/experimental/safety and launch activities at three federal centers of research and one private contractor.

Mr. Revill. When will all of this work be completed?

Mr. Vaughan. This work will be completed when the advanced designs provide reasonable assurance that plant performance levels are competitive with other sources of electricity production and embody passive safety characteristics, investment protection measures, and construction/licensability schedules and costs that are acceptable to the marketplace. Our best estimate is that a private sector firm commitment will not be forthcoming before the early 1990's.

The draft Strategic Plan, to which I referred earlier, describes a logical sequence of events leading to evaluation of candidate concepts, enhanced development of one or more identified concepts, and, finally, possible demonstration.

[illegible]

Mr. Davis. What are the changing citizenship rates?

Mr. Hughes. Changing citizenship rates refers to the Irish, Guinea-Bissau Base Realm, Somali Refugee Base Cycle, Guinea-Bissau Permanent Resident and Haiti Entrant Base Cycle Immigrant Projects. Although the rates allocated to several of these projects are recognized in prior years, the projects are becoming better defined and the rates more closely focused, particularly with regard to year requirements for the Diversity Entrant Initiative.

SDI PROGRAM APPLICATIONS

Mr. Bevill: What SDI SDI program applications will LMR design lessons be applied to?

Mr. Vaughan: Based upon past program experience, the effort to improve the economics and safety of liquid metal reactors emphasizes modularity, factory fabricability, design standardization, high reliability and availability, ease of maintainability, passive safety features, and advanced instrumentation and control systems. These design lessons combine to produce safe, reliable, and economic nuclear power systems which require less operator and maintenance attention. Since many of these results are also the goals of military powersystems, the liquid metal reactor design lessons are directly applicable, in varying degrees, to all of the Department's Strategic Defense Initiative nuclear reactor projects. Both terrestrial and space applications of nuclear power for defense purposes require the ability to operate for extended periods without maintenance. Reactor designs for space application have the additional requirements of major reductions in size and weight. The designs of these defense reactors will build heavily on the advances of the civilian reactor program in order to meet these requirements.

SPACE SHUTTLE ACCIDENT IMPACT

Mr. Revill: What impact does the recent Space Shuttle accident have on the need for space reactor development, particularly in light of a potential year-long slippage in further launches?

Mr. Vaughan: The recent Space Shuttle "Challenger" accident should have little or no direct impact on space reactor development or deployment. Space reactor power system launches are not planned to occur until the early-to-mid 1990's; thus, no launch schedule slippage impacts are envisioned. We anticipate no alterations of the development schedules for our space reactor projects due to safety issues. Safety has been an integral part of our space reactor design and development efforts from the outset of our programs. Nevertheless, if any information should be obtained from the Challenger accident which bears on space reactor safety, it will be fully applied well before space reactors are launched in the 1990's.

SPACE AND DEFENSE POWER NEEDS

Mr. Bevill. Provide for the record a list of all advanced, military and space reactor concepts currently under consideration; include a description of each, estimated total cost and development time, in years.

Mr. Vaughan. The Small Nuclear Power Source Demonstration Project is intended to provide a nuclear reactor power source as an alternative to the diesel-powered electrical generating systems for North Warning System short range, unattended radar sites. This project will result in a small nuclear power source design and the fabrication, construction, and test of a reactor and an organic Rankine cycle energy conversion system to demonstrate high reliability, reduced operations and maintenance costs, reduced fuel logistics costs and "walkaway" safety. This jointly funded project has an estimated cost of $22.3 million over the years 1985 to 1990.

The SP-100 Space Reactor Program will develop and demonstrate multi-hundred kilowatt--approximately 20 to 1000 kilowatt electric class space reactor power system technology supporting civil and military missions in the early 1990's. The SP-100 concept will utilize a compact, fast spectrum liquid metal cooled nuclear reactor with an out-of-core thermoelectric energy conversion cycle. Phase I, in which the safety, feasibility and capabilities of several space reactor and energy conversion systems were studied and evaluated, was jointly funded by DOE, DOD, and NASA at approximately $51 million from 1983 through 1985. Phase II, in which a fully functional reactor and other system components representative of a space power system will be designed, fabricated and tested under a

simulated space environment, will also be jointly funded at an estimated cost of $451 million for the period 1986 through 1991.

The Multimegawatt Space Reactor Project is developing space reactor concepts and associated technologies to provide several megawatts of continuous power and several hundred megawatts of burst power for future Strategic Defense Initiative missions. Potential heat sources include liquid metal cooled--single or two phase--or gas cooled fast neutron spectrum reactors, and thermal neutron spectrum reactors. Potential energy conversion systems being evaluated include direct and indirect Rankine systems, Brayton cycle systems, Stirling engine systems, advanced thermionic systems, thermoelectric systems, and magnetohydrodynamic systems. The development and evaluation phase is jointly funded by DOE and DOD/SDIO, and is estimated to cost $446 million over the years 1985 to 1991.

The Multimegawatt Terrestrial Powerplant Project entails the design and construction of a 10 megawatt electric nuclear powerplant satisfying U.S. Air Force requirements for reliability, passively safe operation and hardening against specified threats. Six potential designs have been prepared employing liquid metal and light water reactor concepts, and will feature modularity, factory fabrication and high capacity factors. The program is jointly funded by DOE and the USAF, with an estimated cost of $130 million over a 5 to 7 year period.

Mr. Bevill. For each advanced, military or space reactor concept, provide a summary of all cost-sharing arrangements made with other Federal agencies, other governments and private sector companies.

Mr. Vaughan. Cost-sharing provisions through FY 1987 for the Small Nuclear Power Source Demonstration Project, the SP-100 Ground Engineering System, the Multimegawatt Power Systems, and the Multimegawatt Terrestrial Powerplant is shown in a table which I would like to insert in the record.

(The information follows:)

COST-SHARING PROFILE
($ in Millions)

	FY 1985	FY 1986	FY 1987
Small Nuclear Power Source Demonstration Project			
o DOE	0	2.4	2.0
o DOD/USAF	1.5	1.5	1.0
o Atomic Energy of Canada Limited	0	4.0	3.0
SP-100 Ground Engineering System			
o DOE	8.8	16.0	30.0
o DOD/SDIO	8.0	15.0	50.0
o NASA	3.9	4.0	4.0
Multimegawatt Power Systems			
o DOE	0	1.8	23.7
o DOD/SDIO	1.6	14.0	22.5
Multimegawatt Terrestrial Powerplant			
o DOE	0	0	3.0
o DOD/USAF	0	3.0	5.0
Total			
o DOE	8.8	20.2	58.7
o DOD	11.1	33.5	78.5
o AECL	0	4.0	3.0
o NASA	3.9	4.0	4.0

Mr. Bevill. Since the Defense Department has expressed such requirements for nuclear reactor systems, why is it that DOD is not contributing more of the R&D costs?

Mr. Vaughan. The DOD will contribute more than 50 percent of the costs of the Space and Defense Power Systems program in FY 1987. For example, the DOE FY 1987 funding request for this activity totals $71.6 million, while the DOD funding for those same projects is $92.5 million. Cost sharing arrangements for each project are individually negotiated, under the general ground rules that DOE support emphasizes research and development activities, and the user agency pays for the end product, such as flight hardware. We believe that the FY 1987 DOD funding level represents a satisfactory level of commitment to Space and Defense Power Systems, provides for adequate DOE funding to preserve requisite management control and flexibility, and is ample evidence of DOD's serious interest in these nuclear energy sources.

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SP-100 PROJECT

Mr. Bevill. Describe the current reference mission for the SP-100 and explain all changes to it since FY 1985.

Mr. Vaughan. In September 1985, a reference mission for SP-100 was established. This reference mission is an early 1990's launch and space flight demonstration of a 300 kilowatt electric SP-100 space reactor power system driving one or more electric propulsion units for the Strategic Defense Initiative Organization. This planned flight demonstration would, first, demonstrate SP-100 as well as electric propulsion technologies in space; second, flight qualify both SP-100 and electric propulsion systems; and, third, prove both the feasibility and utility of actually maneuvering space platforms to enhance their survivability and to offer an available means for their virtually unlimited, ready spatial transfer. No changes have been made to this reference mission since FY 1985.

Preliminary planning for this flight demonstration was initiated by SDIO in late FY 1985 and funding for it has been included in SDIO's budget projections beginning with FY 1987. SDIO's preliminary planning effort is intended to scope the activities, schedule, and costs associated with a 1993 target flight date for this flight demonstration. A preliminary report of this planning effort is expected in the summer of 1986.

DEFENSE ACTIVITIES

Mr. Bevill. What proportion of the total DOE nuclear research budget is devoted to defense activities?

Mr. Vaughan. The proportion of the $330.9 million requested for Nuclear Energy R&D in FY 1987 that is devoted to defense activities is slightly less than one-quarter of that request.

DEFENSE REACTOR PROGRAM

Mr. Bevill. For each defense reactor program proposed, provide the military justification and requirement and identify the specific military mission that each is for; provide for each a Department of Defense certification for the requirement.

Mr. Vaughan. The Department is involved in four defense reactor projects, two for space use--the SP-100 and Multimegawatt Space Reactor Project--and two for terrestrial use--the Multimegawatt Terrestrial Powerplant and the Small Nuclear Power Source Demonstration Project.

In the terrestrial area, the Multimegawatt Terrestrial Powerplant project, formerly called the Secure Military Powerplant project, is a 10 megawatt electric nuclear powerplant which will be highly invulnerable to outages caused by specified military threats. It will be hardened against threats such as electromagnetic pulse and chemical and biological attack and will be relatively invulnerable to sabotage and to acts of nature. Based on numerous exercises, studies, and actual occurrences of loss of power to mission critical installations, the Air Force has decided that a nuclear powerplant offers sufficient promise to warrant proceeding with the design of a Multimegawatt Terrestrial Powerplant. This decision was communicated to DOE in a November 20, 1985, letter from the Air Force Director of Engineering and Services.

The Small Nuclear Power Source Demonstration project will develop a 15 kilowatt electric nuclear powerplant for possible use in the upgraded North Warning System. This powerplant offers a reliable source of power

which is independent of logistics support to a degree which is orders of magnitude greater than that of currently used diesel generator sets. Since the radar stations at which this plant will be used are sited at remote locations and in a harsh environment, the nuclear power source will be unattended except for infrequent maintenance periods, thus further reducing the logistics requirement while providing greater reliability than experienced with diesel generator sets. A Memorandum of Understanding between DOE and the Air Force is being processed for signature. This MOU specifies the purpose and scope of the project.

In the space area, the SP-100 Space Reactor is a cooperative effort among DOE, DOD, and NASA to develop and demonstrate multi-hundred kilowatt electric class--up to about 1 megawatt electric--space reactor power system technology in support of a broad range of military and civilian space applications, in the early to mid-1990's and beyond. Although a specific mission commitment has not yet been finalized, the Strategic Defense Initiative Organization has expressed its plans to conduct a nuclear electric flight demonstration of a 300 kilowatt electric SP-100 space reactor power system driving an electric propulsion unit or units in the early 1990's. Preliminary planning for this flight demonstration was initiated by SDIO in late FY 1985. That effort is intended to scope the activities, schedule, and costs necessary to support a 1993 target flight date; a preliminary report is expected in the June/July 1986 timeframe. This flight demonstration would demonstrate SP-100 and electric propulsion technologies in space, and flight qualify both SP-100 and electric

propulsion systems so that they would then be readily available for specific military and civilian space missions.

In moving toward the ultimate deployment of SP-100 systems and in support of dedicated and specific space missions, the three participating agencies--DOD, DOE, and NASA--signed a Memorandum of Agreement in October 1985 to jointly develop and ground demonstrate SP-100 technology to the point of flight readiness. In addition, DOE and SDIO signed an SDIO Work Package Directive which encompasses engineering development and ground demonstration testing of a 300 kWe SP-100 space reactor power system in a simulated space environment during the FY 1986-1991 period. Upon successful achievement of ground and flight demonstration, SP-100 would be readily available to satisfy specific space mission needs in the areas of surveillance, acquisition, tracking, and discrimination; communications; navigation; orbital transfer and propulsion; electronic countermeasures; and weapons platform quiescent power; as well as a host of other military and civilian space applications.

Also in the space area is the joint DOD/DOE Multimegawatt Space Reactor project. It is focused on investigating a variety of concepts, assessing and advancing both generic and concept specific technologies, and selecting at least one reactor concept by 1991 which can meet SDI requirements. Consequently, the Multimegawatt Space Reactor project is a research effort through 1991 which will result in establishment of technical and safety feasibility and selection of a design concept for potential engineering development and ground demonstration testing. Because SDI's space defensive weapons power requirements are demanding--up

to tens of electrical megawatts for long durations and hundreds of electrical megawatts for short test and engagement times--orders of magnitude improvements will be required in technology to ensure compactness and cost effectiveness, particularly from a launch cost standpoint. As a result, technology assessment and advancement to establish feasibility by 1995 must be pursued. The Multimegawatt Space Reactor project is a joint research effort between DOE and DOD for which an IOTD Work Package Directive has been signed. This Work Package Directive addresses the FY 1990-1991 timeframe and the activities which DOE is to pursue to arrive at technical and safety feasibility and selection of a single concept by 1995.

Mr. Dunkin: Has DOD or DOE requested legislative authorization from the Armed Services Committee for each of the defense space programs? If not, why not?

Mr. Vaughan: DOD has not requested legislative authorization from the Armed Services Committees, as DOD's space and defense fuels systems programs are authorized by the House Committee on Science and Technology and the Senate Committee on Energy and Natural Resources. DOD's responsibilities in the defense space programs are authorized by the Armed Services Committees, but not exclusively so. A specific project/program basis. This procedure arises in that DOD activities such as the Strategic Defense Initiative program are authorized in several ways (Armed, such as Survivability, Lethality, and the Technologies. This leading Service space unit, in turn, derives space projects, but these projects are usually not shown individually as line items in the DOD budget. This has been discussed, however, in testimony, already budget increases are authorizations before the Armed Services Committees.

DOE/SDI MISSION

Mr. Bevill. What is the specific DOE/SDI mission that will be supported by the nuclear energy research program?

Mr. Vaughan. The overall goal of the Strategic Defense Initiative program is to establish the feasibility of a defensive shield against ballistic missiles. The near-term objective of the DOE/SDI effort focuses on determining the technical feasibility of key technologies that would be required for such a shield and that would enable a decision as to whether to proceed in the early 1990's with engineering development of the defensive shield. One of these key technologies is power, especially for potential space-based systems, because space defense systems will not be functional without a viable power source. The space power requirements will include continuous power in the hundreds of kilowatts, tens of megawatts for intermittent continuous power, and hundreds of megawatts for burst power. The space reactor research and development efforts are directed to assure the feasibility of a power system for each of these power requirements. In addition, if SDI should decide to pursue ground-based systems, the terrestrial reactor efforts in the multimegawatt regime will be considered for these applicabilities.

REMEDIAL ACTION

Mr. Bevill. Provide a table showing the status of each project under the remedial action program, including: expenditures to date, FY 1987 request, cost to complete, projected completion data; comments as necessary.

Mr. Vaughan. I will provide a table for inclusion in the record with this information.

(The information follows:)

REMEDIAL ACTION PROGRAM
(B/A in Millions)

	Prior Years	FY 1985 Actual	FY 1986 Adjusted	FY 1987 Request	To Complete	TEC	Year Complete
FUSRAP	$ 60.0	$ 17.8	$ 18.9	$ 25.6	$552.7	$675.0	2001
Grand Junction	15.4	1.5	0.9	0.8	0	18.6	1988
UMTRAP	89.9	60.7	91.4	126.0	513.4	881.4	1993
Surplus Facilities	45.6	29.3	39.9	56.4	628.8	800.0	2005
West Valley	61.5	47.1	61.6	79.0	171.1	420.3	1990
Remedial Action Program Total *	$272.4	$156.4	$212.7	$287.8	$1,866.0	$2,795.3	

* Excludes program direction expenses

Mr. Bevill. For each remedial action program, provide a narrative description of the impact of 10% and 20% reductions and a project-by-project list of projected slippage.

Mr. Vaughan. Reductions of 10 or 20 percent would have substantial impacts on our remedial action programs. A 10 percent reduction, amounting to $28.8 million, would reduce FUSRAP funding by $2.6 million, Grand Junction remediation by $0.1 million, UMTRAP by $12.6 million, Surplus Facilities by $5.6 million, and West Valley by $7.9 million.

Let me briefly summarize some of the specific impacts of these reductions.

Remedial action at Albany, Oregon, would be deferred until FY 1988, and activities in support of FUSRAP disposal site selection for New York and New Jersey would be delayed. No impacts to the current schedule would occur at our Grand Junction project. The start of remedial action at Grand Junction and Gunnison, Colorado, and Riverton, Wyoming, would be delayed until FY 1988, and at Mexican Hat, Utah, until FY 1989. Radiological characterization and engineering for all outyear sites would be slowed down. Cleanup of the Weldon Spring, Missouri, Quarry would be delayed by 4 months, and initiation of remedial action at the Monticello, Utah, mill site would be postponed by 4 months, and decontamination and decommissioning of the SNAP-8 Test Facility in Santa Susana, California, would be delayed by 6 months. We project that vitrification activities at West Valley, New York, would be delayed for one year, supernatant

processing would be delayed by 6 months and the site D&D would be stretched out by 1 year.

A 20 percent reduction of $57.6 million would reduce FUSRAP by $5.1 million, Grand Junction by $0.2 million, UMTRAP by $25.21million, Surplus Facilities by $11.3 million, and West Valley by $15.8 million. We estimate that this would defer remedial action at all sites until completion of interim cleanup at the four sites assigned to DOE by the FY 1984 Energy and Water Development Appropriations Act. Completion of disposal action at the St. Louis Airport Site would be delayed to approximately 1993. The start of disposal action at the St. Louis Airport Site would be delayed by about 6 months, and disposal site selection activities in New York and New Jersey would be indefinitely postponed. Completion of the Grand Junction cooperative program with the State of Colorado would be delayed until FY 1989. The start of remedial action at Grand Junction and Gunnison, Colorado, Riverton, Wyoming, and Ambrosia Lake, New Mexico, would be delayed until FY 1988. At Mexican Hat, Utah, remedial action would not be started until FY 1989, and ongoing work at Durango, Colorado, would be delayed by 6 months. Radiological characterization and engineering for all outyear sites would be delayed. The overall project schedule would be delayed due to impacts on critical path actions, and extension of the Congressional authorization by an additional year would be required. A 20 percent reduction would also mean that cleanup of the Weldon Spring, Missouri, Quarry would be delayed by 7 months, remedial action at the Monticello, Utah, mill site would be delayed by 6 months, and the start of decommissioning at the SNAP-8 Test

Facility, the Ultra High Temperature Reactor Experiment at Los Alamos, New Mexico, and the Power Burst Facility at the Idaho National Engineering Laboratory in Idaho would be postponed. Completion of all West Valley systems would be delayed by 1 year, some D&D tasks would be indefinitely postponed, and the risk of environmental complications from kerosene contamination would be increased.

I would like to submit a table for the record that shows a project-by-project slippage.

(The information follows:)

REMEDIAL ACTION PROJECT SCHEDULES
ASSUMING FUNDING REDUCTIONS

FUSRAP	-10%	-20%
Maywood, NJ	No slip	No slip
Wayne, NJ	No slip	No slip
Colonie,NY	No slip	No slip
Hazelwood, MO	No slip	No slip
SLAPDS, MO	No slip	6 months
Albany, OR	1 year	3 years
NFSS, NY*	No slip	No slip
Middlesex Landfill, NJ*	No slip	No slip
Middlesex Sampling Plant, NJ*	No slip	No slip
NJ Disposal Site	1 year	1 year
NY Disposal Site	1 year	1 year
GJRAP	No slip	1 year

* Complete prior to FY 1987.

DOE REMEDIAL ACTION PROJECT SCHEDULES
ASSUMING 10 AND 20 PERCENT FUNDING REDUCTIONS

(continued from previous page)

UMTRAP	-10%	-20%
Canonsburg, PA*	No slip	No slip
Salt Lake City, Utah	No slip	No slip
Shiprock, NM	No slip	No slip
Durango, CO	No slip	1 year
Gunnison, CO	6 months	1 year
Grand Junction, CO	6 months	1 year
Rifle, CO	1 year	2 years
Riverton, WY	6 months	1 year
Tuba City, AZ	No slip	No slip
Mexican Hat, UT	1 year	1 year
Lakeview, OR	No slip	No slip
Ambrosia Lake, NM	1 year	1 year
Naturita, CO	1 year	2 years
Falls City, TX	1 year	2 years
Green River, UT	1 year	2 years
Slick Rock, CO	1 year	2 years
Belfield/Bowman, ND	1 year	2 years
Maybell, CO	1 year	2 years
Lowman, ID	1 year	2 years
Spook, WY	1 year	2 years
Monument Valley, AZ	1 year	2 years
Edgemont, SD*	No slip	No slip
SFMP		
NFSS, NY*	No slip	No slip
Shippingport, PA	No slip	No slip
Weldon Spring, MO	4 months	7 months
Mound Laboratory, OH	No slip	No slip
Monticello, UT	4 months	6 months
LANL, NM	No slip	6 months
CEER, PR	No slip	No slip
Santa Susana, CA	6 months	6 months
INEL, ID	No slip	6 months
ANL-East, IL	No slip	No slip
West Valley	6 months	1 year

* Complete prior to FY 1987.

Mr. Myers. What is the purpose of spending $41 million on light water reactor research?

Mr. Vaughan. The $41 million funding for light water reactor research is for a program to support the certification by the NRC of advanced LWR designs by the early 1990's. This program is being performed in cooperation with the industry.

Key elements of the program include continuation of the Three Mile Island R&D program to provide information useful to design and regulation of reactors, an advanced LWR technology program to develop innovative design features needed for next generation plants, and a safety and licensing program to provide the technology needed to assist in improving the regulatory process.

Mr. Myers. Do you predict any light water reactors to be built for commercial use in the foreseeable future?

Mr. Vaughan. Assuming the successful accomplishment of the goals as stated in the FY 1987 budget, light water reactors could be ordered in the United States in the early 1990s.

LICENSING

Mr. Myers. Do you believe that licensing of reactors could become quicker and simpler if so-called "inherently safe reactors" became commercially available?

Mr. Vaughan. Yes. The commercial availability of "inherently safe reactors" should result in a substantially quicker and simpler licensing process. Reactor designs that rely on natural or "inherent" mechanisms to bring a plant to a safe shutdown condition are greatly simplified, have fewer overall plant systems, and are therefore susceptible to a more expedient licensing review. Many of the systems eliminated by an inherently safe design approach are "engineered safety systems" that have heretofore been relied upon for safe reactor shutdown and heat removal. The elimination of these safety systems and related licensing reviews will help expedite licensing. Many of the off-normal events that result in consequences that challenge the integrity of conventional plant designs and that require specific safety systems for attenuation, do not occur with inherently safe designs, and, thus, extensive analysis of these events is eliminated. Among these are potential LMR severe accidents that have required detailed and very time consuming NRC reviews for conventional plant designs in the past.

The NRC recognizes the potential of these new innovative designs for bringing about larger safety margins and simplified reviews and has established an advanced licensing group to review the new designs and proposed plans for improved licensability.

The reliance on inherent safety coupled with the standardized design philosophy--where only site specific issues need be considered for follow-on plants--will result in a much simplified and timely licensing process.

ADVANCED REACTOR DEVELOPMENT

Mr. Myers. Why the drastic reduction in support for advanced reactor development?

Mr. Vaughan. We see two factors at work here. The first is the need to focus on key technical issues identified to date and feed back the solutions into design concepts--where they will be incorporated and measured against design goals. With continued funding, it is appropriate to focus on technology issues to achieve reduced costs, passive safety, and licensing acceptability. The second factor is emerging near-term space and defense energy applications which require earlier deployment than advanced civilian reactors. An example of this would be the Strategic Defense Initiative and its multiple concepts for which advanced nuclear power technology is frequently the most advantageous choice to meet power requirements. As I explained earlier to Mr. Bevill, DOE has recommended applying the civilian reactor development capability to meet growing SDI needs instead of developing a new, separate, and costly program capability unique to SDI applications.

The advanced reactor program's success depends on resolving key technology and regulatory issues. A key objective will be to achieve the level of inherent characteristics necessary to provide a passive shutdown of a reactor system and remove its decay heat without operator action and without reliance on complex "engineered" safety systems. Also, interactions with NRC must verify that the new design and licensing approaches are feasible. Finally, additional economic analysis must be conducted to verify that perceived cost improvements are obtainable. Economic advanced reactor concepts cannot be designed or developed without these basic understandings in hand. The proposed FY 1987 advanced reactor research and development budget does not preclude developing this information on a timely basis.

Mr. Myers. Have there been any milestones since last year in advanced reactor development?

Mr. Vaughan. The achievements in the civilian advanced reactor program in the past year have been remarkable. Inherent safety technology programs, now being demonstrated in EBR-II with metal fuel, and to be tested in FFTF for oxide fuel, are proving that the advanced Liquid Metal Reactor can be designed to be immune from damage or accident caused by component or operator failure. Reference fuel performance has exceeded its design goal by 50 percent, and advanced clad for long life cores is performing equal to expectations. All equipment for the secure automated fuel fabrication line has been purchased and is being installed. This system will have built-in real time assay and safeguards accountability. Pumps and steam generators are working reliably. Innovative design concepts form a framework to both incorporate the technology and to guide technology development. On the basis of commodities and prevailing labor/cost standards, these concepts show every promise of meeting their economic goals, particularly capital cost. They incorporate the evolving inherent safety technology, as well as modularization for shortened construction schedule, advanced seismic hardening, and the evolving advances in instrumentation, control, diagnostics, robotics, and smart sensors.

The program is attaining a record of remarkable success that shows great promise of sustaining world leadership for the U.S. in civilian advanced reactor technology.

METAL FUEL BREEDER CONCEPT

Mr. Myers. What is your opinion of the metal fuel breeder concept?

Mr. Vaughan. The metal fuel reactor concept is based on work being done by Argonne. Metal fuels have demonstrated a potential for improving inherent core shutdown mechanisms following abnormal operating conditions in liquid metal fast reactors and for reducing fuel cycle costs. Because of these potential advantages, DOE plans to continue funding the metal fuels effort at least through the current feasibility demonstration phase. There is not an overall commitment to proceed with a specific metal fuel reactor concept. Such consideration would depend on, in part, the results of the feasibility program.

Mr. Bevill. What is the Energy Research Advisory Board's (ERAB) view of the metal fuel breeder, especially of Argonne's Integral Fast Reactor?

Mr. Vaughan. The ERAB Advanced Reactor Development Subpanel will most likely formally address the issue of the breeder and Argonne's Integral Fast Reactor. To date, the ERAB panel report has not been submitted to Secretary Herrington. However, from past public meetings, the Advanced Reactor Development Subpanel appears to be supportive of the Department's current direction and focus on the development of advanced modular liquid metal reactor systems, including the possibility of using a metal fuel system.

Mr. Myers. What do the nuclear reactor firms think about the possibility of metal fuel reactors?

Mr. Vaughan. DOE is funding two Advanced Liquid Metal Reactor concept studies--the Sodium Advanced Fast Reactor, or SAFR, and the Power Reactor Inherently Safe Module, or PRISM. Both are considering using metal fuel, if metal fuel feasibility is successfully established. The potential added safety margins and possible lower fuel cycle costs are desirable attributes. The General Electric SAFR design is currently using a metal core as its basis for design with an interchangeable oxide core as backup. The Rockwell International PRISM design assigns an equal footing to metal and oxide fuels and is awaiting the metal fuels feasibility demonstration results before establishing a preference.

SPACE AND DEFENSE POWER SYSTEMS

Mr. Myers. Do you object if the Committee chooses to fund your space and defense power system reactor R&D out of the Defense Programs?

Mr. Vaughan. The Department would attempt to accommodate whatever funding structure the Committee decides upon. However, we would point out that the Department proposed in its FY 1986 budget that Defense Energy Projects be funded under the Atomic Energy Defense Activities account, which would have included transferring authorization responsibility in the House from the Committee on Science and Technology to the Committee on Armed Services. This proposal was not received favorably by those committees, so we reverted to our traditional approach and requested funding under the Energy Supply R&D account.

With regard to the Department's internal budgeting and management structure, Space and Defense Power Systems are assigned to the Office of Nuclear Energy rather than to the DOE Office of Defense Programs. We believe this assignment is appropriate in that the nature of the work to be performed is nuclear energy and reactor development, which is under the purview of the Office of Nuclear Energy. Regardless of the source of funds, this work would continue to be managed within the Office of Nuclear Energy. Moreover, recognizing the many common technologies and facilities requirements between Space and Defense Power Systems reactor development activities and the Department's Civilian Reactor Development Program, we believe that both the common management and funding of these programs is more effective than splitting up these activities between two different budget accounts or organizations within the Department.

EXTENDED FUEL BURNUP

Mrs. Boggs. Please give us a status report on the Extended Fuel Burnup Program.

Mr. Vaughan. In accordance with the Conference Report that accompanied the FY 1986 Energy and Water Development Appropriations Act, funds appropriated in FY 1986 are being utilized to close out Federal involvement in this program.

Available funds were sufficient to fully fund all of the outstanding contracts except those with Westinghouse Electric and Duke Power. For those contracts, sufficient funds are available to continue activities through FY 1986 and to provide closeout funding thereafter.

LOW-LEVEL WASTE STORAGE COMPACTS

Mrs. Boggs

~~Mr. Bevill.~~ What is the status of the various low-level waste storage compacts?

Mr. Vaughan. The passage and enactment of Public Law 99-240, the Low-Level Radioactive Waste Policy Amendments Act of 1985, has resolved an impasse that has heretofore delayed for 3 years congressional consent to interstate compacts for the regional disposal of low-level waste. On December 19, 1985, the Congress passed this Act and ratified as companion legislation the seven regional compacts submitted to Congress thus far. On January 15, 1986, the Act was signed into law. Thirty-seven States have formed seven regional compacts that were ratified by Congress as part of the Omnibus Low-Level Radioactive Waste Interstate Compact Consent Act--the Rocky Mountain, Southeast, Northwest, Central, Midwest, Central Midwest, and Northeast compact regions. Other States are in the process of forming compacts that have not yet been fully ratified and submitted to Congress for consent. These include the Appalachian Compact proposed by Pennsylvania, possibly with contiguous States such as West Virginia, Maryland, and Delaware; and the Western Compact proposed by California, possibly with Arizona and/or South Dakota. Following the results of a special election in South Dakota, a proposed Dakota compact probably will not proceed. Therefore, North Dakota and South Dakota will seek to join other compacts. Texas continues to maintain its go-it-alone status while Maine, Massachusetts, New York, New Hampshire, Rhode Island, Vermont, Puerto Rico, and the District of Columbia remain unaffiliated.

DEFENSE APPLICATIONS OF NUCLEAR ENERGY

Mr. Fazio: Why is it appropriate for the Nuclear Energy R&D account to be asked to assume the burden for defense applications? Particularly Starwars? Why don't these costs get scored against last year's weapons base? Please define the defense programs which are supported in the R&D budget. Distinguish them categorically from energy programs which are supported in the atomic defense accounts of the DOE budget.

Mr. Vaughan: The Nuclear Energy R&D account has historically included defense nuclear energy R&D projects as well as actual deployment projects. All former Systems for Nuclear Auxiliary Power projects to develop special purpose isotopic and reactor power systems were included in the Nuclear Energy R&D account--many of those projects were in support of defense as well as civilian applications. The nature of such activities, both historically and today, requires expertise and experience with nuclear power supplies and their associated technologies. That expertise and experience continues to reside in the DOE Office of Nuclear Energy, which is responsible for nuclear energy projects having both defense as well as civilian application. Efficiency in government alone supports such a centralized approach.

Our current defense nuclear energy programs include five jointly funded projects--namely, the SP-100 and Multimegawatt Space Reactor projects, the Multimegawatt Terrestrial Powerplant project, the Small Nuclear Power Source Demonstration project, and the Dynamic Isotope Power

System project. These projects are described in our FY 1987 budget submittal in detail.

Although these projects are currently focused on defense needs, they also have potential utility to the civilian sector. For example, the SP-100 Space Reactor is a joint effort among DOD, DOE, and NASA to develop and demonstrate multi-hundred kilowatt electric class--up to about 1 megawatt electric--space reactor power system technology in support of a broad spectrum of military and civilian space applications in the 1990's and beyond. Examples of space applications that would be enabled or significantly enhanced by SP-100, in the military as well as the civilian sector, include communications and data transfer, navigation, and orbital transfer and propulsion, just to name a few. Therefore, although defense applications are the primary focus of our current projects, these projects do have potential civilian applications as well.

These same projects are not funded out of the weapons base because they are not weapons but power supplies. That is, they are clearly distinguishable from activities that have historically been and continue to be included in the atomic energy defense accounts of the Department. The projects currently being pursued by the Department in support of the President's Strategic Defense Initiative maintain this distinction. For example, SDI-directed energy weapons R&D funding involving lasers, particle beams, etc., is appropriated through the Department's Atomic Energy Defense activities account, while R&D on nuclear power supplies in support of SDI, non-SDI military, and civilian applications are included in the Department's Nuclear Energy supply R&D account. This is appropriate and

fully consistent with the Department's charter, past efforts, and current organizational structure and expertise. We believe that the FY 1987 DOD funding level represents a satisfactory level of commitment to Space and Defense Power Systems, provides for adequate DOE funding to preserve requisite management control and flexibility, and is ample evidence of DOD's serious interest in these nuclear energy sources.

Mr. Fazio. To what extent is the nuclear-related work for the Strategic Defense Initiative consistent with the President's public assertions that starwars will not involve nuclear weapons in space? Will DOE work be aimed at powering weapons which actually strike using the nuclear generated energy?

Mr. Vaughan. The projects undertaken by the Department's Nuclear Energy R&D Program in support of the Strategic Defense Initiative involve the development of nuclear electrical power supply systems to meet a range of SDI specified requirements.

ALTERNATIVE TECHNOLOGIES

Mr. Fazio. Last year the Congress indicated that it wanted the Department to continue to explore alternative technologies for the future of fission energy, with there being three principal technologies under consideration--advanced light water reactors, liquid metal reactors, and high temperature gas cooled reactors. Is it true that this year the Department proposes to increase light water funding, decrease liquid metal funding, and virtually kill the HTGR?

Mr. Vaughan. The Light Water Reactor funding request is down from the $50 million FY 1936 estimate. The Advanced Reactor R&D request would continue effort on Liquid Metal Reactor and High Temperature Gas Reactor programs but at funding levels that reflect a deliberate focus on economic, regulatory and technology issues which have been identified. It is our intent to continue R&D in support of addressing those issues which must be resolved before economic advanced reactor concepts can be developed and commercialized by the private sector and to establish a program pace consistent with the perceived need for advanced nuclear power generating units in the market place.

Mr. Fazio. Why should the Department of Energy do any more work on light water reactors, "advanced" or not, since they predominate in the marketplace now? Why should not the private sector be asked to carry the light water reactors forward from here, as the private sector is typically asked to do even for technologies that are not established in the marketplace.

Mr. Vaughan. We believe that future viability of the nuclear option requires that LWR's be available in a form that will be attractive to the utilities. The private sector funding for new product lines is not available in sufficient quantity, because of the higher priorities of R&D on operating plants and plants under construction, and because the regulatory and economic outlook does not provide an adequate incentive. Because the availability of the nuclear option is in the national interest, DOE is performing supporting R&D to assist industry's development of new systems which incorporate innovative features which will simplify regulation and make the reactors more attractive to the industry.

LIGHT WATER REACTORS

Mr. Fazio. Do you really think that light water technology is the best option for the future? What do you say to the idea that the Department continues to support the approach mostly because it is an interest vested in the Department and the existing nuclear fission community?

Mr. Vaughan. We believe there will be an orderly progression of technology as there has been historically in all other industries. Realistically, the LWR is the only reactor system that can be deployed in the United States in the near term. The utility industry is actively developing detailed requirements for the next generation of LWR plants. We believe that such plants can be certified and deployed in the early 1990's and offer the best opportunity for revitalization of the nuclear power option in the national interest to meet future market demands. To forego this opportunity now would be extremely shortsighted.

HIGH TEMPERATURE GAS REACTOR

Mr. Fazio. Why did the Budget propose virtually killing the high temperature gas reactor programs?

Mr. Vaughan. The FY 1987 budget does not propose to eliminate the HTGR program. Actually, the FY 1987 budget supports reasonable progress toward performing an evaluation of all candidate reactor concepts as discussed in our draft Strategic Plan. The HTGR program is uniquely aimed at the satisfaction of longer term needs, including high temperature applications. The unique capability of the HTGR to contribute to high temperature process heat applications continues to be explored by DOE and is considered to be of significant merit in terms of resource extension. The proposed budget recognizes these factors.

We are continuing to advance the HTGR by focusing on key technology issues that need resolution. The issues of interest are demonstration of the passive safety capability of a natural air circulation cooling system, improved fuels performance, development of highly reliable bearings for circulators, and development of steam generators. Additionally, the intensive look at the nature and direction of the HTGR program allows us the opportunity to assess foreign cooperative possibilities and to determine the degree of advancement that can be mutually achieved with joint programs.

COST SHARING

Mr. Fazio. Industrial support for a technology is not only cultivated as a way to share costs and leverage federal investment, it is taken as a sign that a technology has real promise. It is perceived as a signal from the marketplace. Has any industry group other than the High Temperature Gas Cooled Reactor Associates come forward on its own with an offer to cost share and with a specific research program leading towards the development of a reactor.

Mr. Vaughan. Yes, there are cost sharing arrangements on other nuclear technologies as well. The nuclear industry has developed designs for advanced LWR's. The funds for work on these plants to date is perhaps $500 million. In addition, the utility industry is actively pursuing generation of requirements documents for future plants and development of mid-sized plant designs. Industry has requested DOE help with technology support for certain innovative design features of these plants on a cost-shared basis. This cooperative effort is expected to result in certification of two or more advanced LWR designs by the early 1990's.

The LMR design activities being conducted by General Electric and Rockwell contain the development of industrial support and a project plan similar to that which was recently prepared by Gas Cooled Reactor Associates. We have reviewed early drafts of the plans, and they contain a number of similar activities. I have here a quote from the "Joint Participants' Statement of the HTGR Program,"--and I think all of the LMR and HTGR contractors would agree--that "it is recognized and accepted that

the key to the success of the Project is the ability of the private-sector participants to raise a significant fraction of the Project funds." When such a condition is met, DOE can give serious consideration to entering into negotiations and identifying appropriate Government participation in a project. As to specific research programs leading toward development of a reactor, both of the LMR contractors have supplied R&D needs documents that have been a major factor in determining the R&D tasks we have undertaken in fiscal year 1985, 1986, and 1987 in the LMR R&D program.

Mr. Fazio. Why is this signal on the HTGR from the marketplace being discounted?

Mr. Vaughan. We are not ignoring this proposal. We have reviewed versions of the Gas Cooled Reactor Associates' report on a Project Definition Study and are in possession of a final draft. We consider the report to be well put together containing all the elements that one would anticipate seeing in such a study. In our discussions with GCRA, we have made it clear that the successful initiation of a project will require a substantial contribution from the industry. Such a contribution is not forthcoming at the present time. As I understand it, GCRA is continuing to move forward to develop a strategy based on the project definition studies. We will be working closely with GCRA to follow the progress in their efforts to identify funding and contributors necessary for the successful formation of a project.

NUCLEAR PLANT OPERATIONS

Mr. Fazio. It is obvious that there are structural problems within the nuclear industry: it is difficult to recruit personnel; nuclear plant operators work in a regular utility context on those pay scales, and yet handle matters which are qualitatively different from those handled by their non-nuclear colleagues; the enormous capital investment required for nuclear facilities means that any utility which undertakes to build or even retrofit one is risking a very substantial portion of its corporate assets.

Do you foresee a day when firms specializing in nuclear plants operate several and wholesale their output to regional utilities? Please provide documentation comparing nuclear plant workers' salaries with pay scales for utilities in general.

Mr. Vaughan. The type of firms to which you refer would be so called "generating companies." This is an idea which has been discussed at various times by both industry and Government as an alternative institutional arrangement which may have merit. Numerous utilities already jointly own nuclear powerplants and wholesale power to other utilities. The plant operator is normally one of the larger shareholders of the plant. To date, non-utility firms have not shown much interest in participating in nuclear plant ownership. One of the reasons is that the Public Utility Holding Company Act would subject these non-utility firms to state PUC, or Federal FERC economic regulation if they owned more than 10 percent of the plant. In general, these companies do not wish their activities subjected to additional regulation by state or Federal Government agencies.

Nuclear utility plant workers' salaries compared to general utility pay scales vary from utility to utility. However, based on estimates from DOE's Energy Information Administration and Oak Ridge National Laboratory, an approximate 5 to 10 percent average premium is paid to nuclear utility workers compared to general utility pay for similar types of jobs.

UTILITIES MANAGEMENT OF NUCLEAR FACILITIES

Mr. Fazio. Might utilities form consortia to finance and manage nuclear facilities on a regional basis?

Mr. Vaughan. Many utilities already participate in joint ownership of nuclear plants for purposes of financing them. In addition, there are a few holding companies, such as Middle South Utilities, which manage and operate nuclear plants for the utilities which are a part of the holding company. However, management of the construction and operation of those plants is generally performed by the lead utility, typically the largest owner.

Mr. Fazio. Might DOE's research be targeted towards reducing capital exposure; decreasing lead time for construction; simplifying management?

Mr. Vaughan. Indeed, it is DOE's advanced LWR program contains a number of activities looking to simplify construction methods and construction management. In addition, our regulatory reform and certification support activities should reduce the overall plant lead time. Such resultant lead times for construction could lead to substantial reduction in capital exposure.

Competitive costs, short lead times, simplification of plants and plant construction, and plant operation are primary goals of the research program and these factors, along with attainment of inherent safety, also drive the innovative concepts in the LMR and HTGR programs. Market assessments indicate that these are the factors that will determine whether and when new nuclear capacity is ordered. Simplification of construction and inherent safety will produce huge benefits in simplifying management and elimination of financial risk to management, investor, and rate payer. And, importantly, the program test results and the results of innovative concept development show every reason to believe the goals will be achieved and a downward trend restored to power cost in the market place.

Mr. Fazio. What are the R&D implications of the industry's problems?

Mr. Vaughan. The problems can be characterized as financial, institutional, regulatory and technical. They are complex and somewhat interrelated. Technology--particularly technology that attains inherent safety, short lead time, simple construction and operation and capital cost superiority--can diminish the pressures in each of the problem areas to the range typical of any profitable business venture. Further, it is believed that inherent safety attainment can and should be the development that justifies and guides the design of regulatory reform, a condition most often cited as a necessary prerequisite to new nuclear orders by many utilities and financial institutions. Restoration of a downward trend in power costs while restoring fair return to the investor will be welcome by public utility commissioners, rate payers, and investors. Advanced reactor technology is targeted to achieve those goals. While the technology does not, in and of itself, solve all the problems, they will not be solved without it--and successful development of the technology can provide the basis for financial motivation and impetus to deal with the non-technical problems.

PASSIVELY SAFE REACTORS

Mr. Fazio. Please describe the inherently safe (passively safe) characteristics of the ALWR's, LMR's, and HTGR's.

Mr. Vaughan. Advanced LWR designs incorporate design features which provide for a high degree of natural circulation cooling flow. In addition, designs provide for ensuring that the core remains covered with water in the event of a breach in the primary cooling system. Such assurance is provided by innovative plant layouts and by components designed to "fail-safe" and introduce required coolant in the event of an accident.

The passive safety characteristics of HTGR's are derived by utilizing the features standard in all HTGR's, coupled with special features of the modular HTGR. The features that are standard in all HTGR's include helium gas coolant, graphite moderator and core structure, and ceramic coated fuel. The helium gas is inert and single phase and therefore precludes corrosion and facilitates operation. Also, since it is a gas, it is not possible to experience a complete loss of coolant. The graphite moderator has a large thermal inertia that provides long response times for corrective action. Since graphite has high temperature stability--the strength of graphite increases with temperature--the graphite HTGR core structures are stable at very high temperatures. The ceramic coating on the HTGR fuel particles has high fission product retention capability and is capable of operating at very high temperatures above normal operating conditions without failing. Since the fuel particles with this high

quality coating are imbedded in a graphite matrix within hexagonal graphite blocks, the workers experience low radiation exposures and there is low release of radioactivity from these plants. The passive safety features include natural circulating helium cooling within the reactor vessel and a reactor cavity cooling system that assures natural circulating air cooling of the vessel to the environment. Furthermore, the core size, configuration, and designed low power density, coupled with the large graphite heat capacity, and high retention capability of the fuel, maintain safe temperatures by conduction and radiation even when helium natural circulation is not possible. The passive features are intrinsic and do not require operator action or active power systems.

All of these should result in a design that possesses a level of safety sufficient to preclude the need to include sheltering or evacuation in the emergency plans for anyone more than 425 meters from the plant.

LMR designs are stressing the maximum utilization of natural forces to restore the system to a safe condition. Forces such as the following are being exploited; thermal expansion, gravity, high sodium conductivity, curie point, and sodium coolant density. The strong negative inherent reactivity feedback mechanisms which are maximized in the advanced LMR designs preclude credible core meltdown or disruption accidents, even under the postulated circumstance of failure of all the control rods and protective systems. This results in the elimination or simplification of complicated engineered safety systems, thereby simplifying control requirements and plant design. Passive decay heat removal systems, which naturally circulate sodium, and redundant reactor and guard vessels

virtually preclude loss-of-coolant accidents or the need for rapid operator response to accident conditions. Any necessary corrective actions can then be carried out in a planned, logical, orderly fashion. Dependence on outside electrical power supplies is virtually eliminated. The sodium coolant is non-corrosive well past its boiling point, while the operating margin to boiling is very large. These inherent attributes of advanced LMR's will greatly ease the licensing process. They will permit designation of the balance-of-plant as high grade industrial rather than nuclear safety grade construction and permit smaller low-pressure containment systems, both leading to significant cost savings.

CHARACTERISTICS OF MODULAR CONSTRUCTION

Mr. Fazio. Please describe the characteristics of ALWR, LMR, and HTGR technologies that make them amenable to medium or small scaling to modular construction?

Mr. Vaughan. There are no special characteristics of ALWR's, LMR's, or HTGR's which make one reactor type more amenable to medium or small scaling than another. The advantages and disadvantages of small versus large are common to all three reactor types. Small modular systems have advantages especially adapted to the U.S. utility industry. The large number of small to medium sized U.S. utilities taken together with slow load growth requirements favor the selection of smaller modular units to meet generating capacity needs. The smaller up-front investment requirements and the early cash flows resulting from shorter construction times for small modular capacity additions are financially attractive.

Modular construction is an option available to all reactor types, but even more suited for smaller sizes. While modularization of a large plant is limited to its subsystems and components, a small plant is able to modularize to a much greater extent. For example, the entire reactor vessel and internals, the containment/confinement, and other major blocks of plant hardware lend themselves to modular factory fabrication and shipment to the plant site. Modularization permits a utility to more closely match reduced growth rates with incremental power additions. When modularization and shop fabrication are coupled with standardized design as is proposed for the advanced designs, the benefits of more efficient quality control, higher productivity, and cost reduction due to utilization of a stable work force can be realized. Small modular systems also offer high plant capacity factors but can require more complex control and fuel handling systems; however, this is largely compensated by the simplified plant systems resulting from passively safe core and heat rejection system designs.

HIGH TEMPERATURE GAS-COOLED REACTOR

Mr. Boner. Please provide a detailed analysis of the benefits to be derived by funding the High Temperature Gas-Cooled Reactor Program at last year's level of $35 million and at an interim level of $20 million instead of the Administration's proposed $5 million.

Mr. Vaughan. The Department's current request is adequate to continue the key development steps for the HTGR given any projected market need for this type of reactor for applications such as process heat generation. At the proposed $5 million level we will continue design activities to further define the passive safety features of the modular HTGR, including the natural circulation reactor cavity cooling system, defining the conceptual design of the advanced circulator with magnetic bearings and providing the basis for a preliminary and analyses to the Nuclear Regulatory Commission to support and supplement the Preliminary Safety Information Document submitted in FY 1986 sufficiently to obtain a licensability statement from the NRC at the end of FY 1987. Technology development activities will focus on fuel performance tests to support the US/FRG and US/Japan international cooperative programs. Also, a preliminary assessment of HTGR applications for defense missions will be completed.

At the $20 million level the program would complete key conceptual design evaluations, including constructability/fabricability assessments, operations and maintenance assessments, availability/reliability assessments, and probabilistic risk assessments. Conceptual design of key systems such as the core, reactor internals, steam generator, fuel handling

and heat transfer systems would be continued. These efforts would provide the basis for the more definitive cost estimate and construction schedule that would be completed with this level of funding. Technology development areas would be expanded to include initiating a test program to verify fission product liftoff and transport characteristics for the modular HTGR and completing the planning for the US/Japan cooperative graphite program. The US/FRG and US/Japan cooperative fuel performance test program efforts would be increased and schedules would be accelerated. Additionally, planning would be completed for performing key features and components performance tests--for example, on the magnetic bearing circulator.

At the $35 million level conceptual design of the modular HTGR would be completed and documented along with a definitive cost estimate and construction schedule. Further design activities and the preperation of a Preliminary Standard Safety Analysis Report for the standardized HTGR design would be performed. Technology development programs would be expanded to include initiating tests on graphite to support the US/Japan cooperative program and initiating key features and components performance test programs. Additionally, technology development to support the advanced, HTGR for very high temperature process heat applications would be continued.

All of the activities that I have just described at the 20 million and 30 million dollar levels are consistent with the concept evaluation addressed by our draft Strategic Plan for the Civilian Reactor Development Program. However, it is important to note that all concepts must be advanced in a coordinated manner in order to permit a balanced concept evaluation. At the 20 and 30 million dollar levels the pace of the HTGR work would be inconsistent with the pace of the other candidate concepts.

JAPANESE COLLABORATIVE EFFORT

Mr. Boner. Please provide an update on any discussions with the Japanese regarding a collaborative effort in fuel cycle technology.

Mr. Vaughan. On Monday, March 10, 1986 the latest in a series of discussions began between DOE and the Power Reactor and Nuclear Fuel Development Corporation of Japan to explore expanded collaborative exchange in fuel cycle technology. While it is too soon to tell what will come from these meetings, preliminary information indicates that these discussions are proceeding well.

Mr. Boner. Have the Japanese indicated an interest in supplying funds at a two-for-one ratio to the United States contribution in such a collaborative effort in fuel cycle technology?

Mr. Vaughan. There have been indications from the management of the Power Reactor and Nuclear Fuel Development Corporation of Japan of the prospect of their providing significant financial support because the U.S. currently has a technological advantage in this area. Details of a potential expanded collaborative arrangement, including funding arrangements, are currently under discussion between DOE and PNC representatives.

Mr. Boner. Industry analysts suggest that such a collaborative effort might result in U.S. sales to Japan of $50 million in advanced equipment. What are DOE's projections and how would they be affected by a fuel cycle technology budget of $5 million instead of the currently proposed $1.5 million?

Mr. Vaughan. The proposed collaboration with Japan could lead to a significant Japanese investment in U.S. research and development and in equipment purchases. There is strong potential that U.S. sales to Japan resulting from the agreement could be very substantial. Specific equipment which the Japanese could be expected to procure include the advanced servomanipulator, centrifugal contactors, robot sample vehicle, remote laser disassembly system, shear system, and a rotary dissolver.

A budget of $5 million in FY 1987 would indicate a U.S. commitment that might improve the prospects of establishing an expanded cooperative arrangement with Japan but it does not assure it. The $5 million would support expanded work on advanced equipment that would make the collaborative arrangement of greater interest to Japan.

STATEMENT OF JAMES W. VAUGHAN, JR.
ACTING ASSISTANT SECRETARY FOR NUCLEAR ENERGY
U.S. DEPARTMENT OF ENERGY

FY 1987 APPROPRIATIONS HEARINGS

Mr. Chairman and Members of the Subcommittee, I am pleased to have the opportunity to discuss the Department of Energy's FY 1987 budget request for Nuclear Energy Supply Research and Development programs. The requested funds are distributed among the program elements as summarized in the following table:

	--($ in Millions)--	
Program Element	FY 1986 Estimate	FY 1987 Request
Nuclear Energy Supply R&D		
Nuclear Energy R&D	$ 375.7	$ 330.9
Remedial Actions and Waste Technology	$ 230.0	$ 294.1
Policy and Management	$ 1.7	$ 1.8
TOTAL	$ 607.4	$ 626.8

A more detailed funding table is included in the discussion of each major program. The FY 1986 figures in these tables reflect appropriated totals reduced by sequestrations responsive to Public Law 99-177 (the Gramm-Rudman-Hollings Deficit Reduction Act), management initiatives, and other general reductions.

OVERVIEW

We place high priority on ensuring that nuclear energy continues to contribute to a strong, stable, and secure national energy base to meet both civilian and military requirements. Nuclear energy, along with fossil and renewable energy sources, are essential elements to achieving that goal at reasonable cost. The Department's commitment to nuclear energy remains strong. Our reactor development programs to help preserve the nuclear power option and our execution of a reliable, competitive, and businesslike uranium enrichment enterprise are an integral part of our commitment. The Department also remains strongly committed to protecting public health and safety and to assuring a safe and clean environment in connection with its activities. Our remedial action and waste technology efforts are an integral part of that commitment.

In assessing our FY 1987 nuclear energy program priorities, we have faced hard choices for many of our program elements in a time of fiscal constraint. While the FY 1987 budget request for Nuclear Energy Supply Research and Development programs increases slightly from our FY 1986 estimate, there have been several shifts in relative funding levels for individual programs. Within that essentially level budget, our funding request for nuclear energy research and development (R&D) has decreased by about $66 million, while funding for Remedial Actions and Waste Technology has increased by some $66 million compared to FY 1986.

Key factors that influenced the formulation of our programs and budget request include:

First, the Department is fully committed to support the bipartisan effort to control and reduce the Federal deficit. In this necessary environment of fiscal constraint, we are constantly faced with difficult choices among deserving programs. Although it may appear to some that worthwhile R&D elements have been eliminated or significantly reduced, we believe that each of our programs is sharply focused to make optimum use of limited resources.

Second, space and defense nuclear energy needs are increasing, particularly those associated with the Strategic Defense Initiative (SDI). Some of our activities in this area have progressed from the design and screening phase into the more funding-intensive hardware phase. These activities are an essential part of a top national priority. Accordingly, our funding request for these efforts in our nuclear energy R&D programs has increased in FY 1987 as previously planned. Certain benefits derived from the nuclear energy R&D work to support these national security requirements will be applied to future civilian reactor development efforts and complementary base technology activities will continue.

Third, our civilian reactor research and development program has been reduced, but more sharply focused on assuring that a path exists to maintain nuclear power as a robust option for the rest of this century and beyond. Last year, we testified that the

institutional and technical impediments to the near-term deployment of light water reactors must be overcome before there would be any chance to realize the potential of advanced reactors. This is reflected in the priorities within the funds available for reactor research and development. Our Light Water Reactor (LWR) R&D program is more sharply focused on research and development which can help facilitate efforts by U.S. industry to usher in a new, advanced generation of nuclear powerplants. The Department's LWR R&D programs will continue to emphasize advanced in safety technology including continued evaluation of the Three Mile Island accident. It is our view that the time is ripe for the completion of development and certification of advanced, state-of-the-art LWR designs. Certainly the currently anticipated timing for the commercial introduction of innovative reactor technologies beyond light water reactors has been stretched out. We have made excellent progress in the past 2 to 3 years on design work for High Temperature Gas Reactors (HTGRs) and Liquid Metal Reactors (LMRs); our focus is now upon key features affecting the economic, passive safety, and technical issues of these concepts. Our funding request for civilian advanced reactor development activities has been reduced in FY 1987 consistent with this extended timing and other nearer-term priorities including space and defense activities.

Fourth, the Remedial Actions and Waste Technology budget request increases by $64.1 million compared to the FY 1986 estimate. The program objectives can be achieved at this level of funding by extending the authorization period for the Department's Uranium

Mill Tailings Remedial Action (UMTRA) Program from March 1990 until the end of FY 1993, consistent with the guidance provided in House Report No. 99-195 accompanying the FY 1986 Energy and Water Development Appropriations Act (Public Law 99-141). We will formally request such an extension later this year. Emphasis in all remedial action programs will concentrate on cleanup activities at the highest priority sites and the continued protection of the public and the environment at all sites.

Finally, the Uranium Enrichment budget request reflects several strategic decisions made by the Department during the past year. Chief among these are placing of the Oak Ridge (Tennessee) Gaseous Diffusion Plant in standby, termination of the Gas Centrifuge Enrichment Plant (GCEP) project, and selection of the Atomic Vapor Laser Isotope Separation (AVLIS) process as the advanced uranium enrichment technology for the U.S. in the 21st Century. During FY 1986, the Department will initiate an effort to transfer development and ultimate deployment of the AVLIS technology to the private sector. The FY 1987 budget request reflects these decisions.

More detailed discussion of these factors and the scope, status, and budget request for our programs is contained in the sections that follow.

NUCLEAR ENERGY RESEARCH AND DEVELOPMENT

The funding request for Nuclear Energy Research and Development is contained in the following table:

Program Element	FY 1986 Estimate ($ in Millions)	FY 1987 Request ($ in Millions)
Nuclear Energy R&D		
Light Water Reactors	$ 48.1	$ 41.0
Advanced Reactor R&D	128.5	49.5
Space/Defense Power Systems	20.2	71.7
Advanced Nuclear Systems	19.5	23.6
Facilities	132.2	121.8
Water Cooled Breeder	19.0	13.8
Program Direction	8.2	9.5
Total	$ 375.7	$ 330.9

The Department has provided R&D support for both the defense and civilian nuclear energy areas for decades and both areas will continue to be served by these proposed programs. It is our intent to integrate and coordinate those efforts to the maximum extent practical so as to minimize the overall cost. The priority of defense nuclear energy programs for military applications has not changed; programs have expanded and moved ahead as planned while the overall funding stringencies have tightened. Two factors are at work. One is the decrease in orders by utilities for new nuclear generating capacity resulting in a relaxation, which may be temporary, of the urgency for advanced reactor technology for civilian applications. The second is the emergence of the Strategic Defense Initiative and its multiple concepts for which advanced nuclear power technology is frequently the most advantageous choice to meet power source

needs. In the face of the urgent need to reduce Government outlays, the Department has recommended an adjustment in the pace of the civilian reactor development program and use of existing capability to meet growing space and defense needs rather than initiate the buildup of a new, separate, and costly program capability unique to space and defense applications. Our programs in support of military and civilian energy needs are complementary. Certain benefits that accrue from each program will be applied to other programs. The principal areas of interface are in application of common technology, facility utilization, and shared use of available expertise in our laboratories and contractors.

Our advanced reactor R&D program builds upon significant past success to focus upon key features related to safety and economics of advanced reactor systems. Application of improved state-of-the-art LWRs represents the most likely path to revitalizing the nuclear power option. Emphasis in our LWR program is on supporting a process leading to enhanced safety; improved, more predictable licensing; and certification of advanced LWR designs.

Supporting all of these R&D efforts will be the continued operation of the unique test facilities and analytical laboratories required for developing and verifying advancements in reactor systems, fuel, components and power conversion systems.

The FY 1987 nuclear energy R&D program consists of the following elements: Light Water Reactors, Advanced Reactor R&D, Space and Defense Power Systems, Advanced Nuclear Systems, Facilities, and Water Cooled Breeder.

A discussion of each of the program elements that comprise the FY 1987 Nuclear Energy R&D budget request follows.

LIGHT WATER REACTORS

From the experience accumulated to date on LWR research, design, construction, operation, and regulation, it is evident that major national benefits can be realized by near-term advancements in each of these areas. Consistent with industry responsibilities, programs are already underway by the reactor manufacturers and the electric utility industry to exploit these opportunities for existing LWR's and, to some extent, for LWR's yet to be committed. The Department's LWR program in FY 1987 will provide additional technical confidence that the benefits of evolutionary improvements to existing LWR's are realized, and will explore the impact and benefits that can be expected from the application of additional R&D efforts to bring more standardized, advanced, state-of-the-art LWR's to fruition in this country within an improved licensing and regulatory system.

The technical support for demonstrated removal of the remaining technical, licensing, and institutional impediments to the construction and operation of next generation LWR's, as well as innovative advanced reactors, is a key objective of our R&D

programs. A key milestone in the pursuit of this objective will be to achieve Nuclear Regulatory Commission (NRC) certification of at least two Advanced Light Water Reactor (ALWR) systems in approximately 5 years. The pursuit of this objective will have the effect of focusing and guiding the Department's efforts in the LWR program area. The major areas of work in the LWR program element are LWR Safety and Licensing, Advanced LWR Technology, and Three Mile Island (TMI) R&D.

LWR SAFETY AND LICENSING

By 1987, more than 100 nuclear powerplants will be generating approximately 17 percent of the Nation's electricity. The use of nuclear power has substantially increased our energy security by greatly reducing the dependence on imported oil. A maximum of 14 additional units are scheduled to come into operation in the United States between 1987 and 1992.

Even with this impressive use of nuclear power, further deployment of this important energy option is threatened. One of the major reasons is the U.S. regulatory system, viewed by many as slow, cumbersome, and ineffective. The central requirement in the Federal regulatory scheme is to assure public health and safety through regulation of nuclear powerplants. Effective regulation consists of a technical component and an understanding of economic impacts of the means used to regulate. The changing positions, policies, and regulations affecting the LWR industry have rendered the technology of decreasing value to end users. Clear and consistent policies and supporting technical bases for

LWR construction and operation will provide the framework for a coherent regulatory policy at both the Federal and state levels. Industry must be able to meet the legitimate requirements of regulators at the state and Federal level. However, the regulatory process itself needs to be more responsive to the energy needs of the next decade and beyond by dealing with safety and licensing matters on a rational, risk-based technical approach.

One of the tasks in this program area is a continuation of the severe accident technology program. Fuel damage testing conducted during prior years culminated in completion of the Loss-of-Fluid-Test (LOFT) program in FY 1986. That program provides the basis for further evaluation of fuel damage tests conducted under cooperative programs with ot. · nations. The focus of follow-on work in FY 1987 will be to translate the results of LOFT program results into sound models and data generally accepted by the technical community as appropriate for use in the licensing process.

The overall goal is to develop and apply a severe accident methodology that incorporates results of all recent experimental work and an understanding of the ability of operator actions to reduce the consequences of accidents through more informed decisionmaking in the control room. Effective consensus in this area is crucial to regulatory reform and a better understanding of the requirements for emergency preparedness at both the local and Federal level.

In addition, risk-based licensing techniques will be developed and coordinated with the Nuclear Regulatory Commission's policy on severe accidents. General agreement has been reached on the use of risk-based techniques, and application of such techniques to achieve improvements in the regulatory process is growing. What remains to be done is to apply these techniques in the consideration of design choices for future reactors. Procedures for considering alternative design features or alternative means of complying with safety standards will be developed and applied. Work in this area will provide increased confidence that advanced light water designs meet all licensing and utility requirements for safe, reliable and economic performance.

Another important effort is a cooperative industry/government program to extend the productivity of existing and future LWR's. The equivalent of 20 new light water reactors could be realized through practical improvements in availability and lifetime of existing LWR's. Plant availability programs will be conducted in close cooperation with industry. A DOE aim is to help assure that nuclear utilities have incentives to continue extended fuel burnup previously initiated by DOE, and to apply previously obtained results. Pilot plant studies on a typical pressurized water reactor and a typical boiling water reactor will identify those components and structures that will be key in deciding to extend plant life time. In FY 1987, efforts will concentrate on technical analyses to determine key reactor plant structures and components that can continue in service beyond 40 years without replacement or refurbishment. This program could lead not only

to an improved Federal regulatory approach, but could also provide a more informed bases for state regulatory evaluations of the economic and the safety impact of investments in improved plant performance.

ADVANCED LIGHT WATER REACTOR TECHNOLOGY

U.S. firms have participated in major joint programs in Japan to develop a new generation of advanced LWR's in the 1,200-1,300 megawatt electric (MWe) power range. The U.S. electric utility industry has begun a smaller effort to draw upon the results of this program, as part of an effort to set the stage for future deployment of standardized advanced light water reactors by U.S. utilities.

Work on Advanced LWRs includes R&D needed to bring forward a new generation of mid-sized LWRs. In the early 1970's, when the U.S. nuclear industry was thriving on high load growth, assumed economies of scale drove plant ratings from the intermediate range (400-800 MWe) to about 1,000 MWe. With today's pattern of lower load growth rates, plants with smaller ratings and lower total capital cost may be required to meet utility needs. The difficulty of obtaining financing for very large construction projects, impacted in part by continued changes in regulatory requirements for existing product lines, has led some U.S. reactor manufacturers to consider developing smaller, advanced LWR concepts. These designs would build on the extensive experience base from the last three decades of reactor operations

but would also incorporate innovative design features. Such features could be less sensitive to changes in regulatory requirements, and also offer reduced construction periods and reduced total plant costs. Because of the relatively large resources needed to develop such designs and the uncertain potential for payoff, these innovative mid-sized LWR concepts have been developed only to a very preliminary stage. Both the market and the regulatory process are too uncertain to practically justify sufficient private sector financial investment necessary to carry the design concepts to a stage at which their potential can be adequately assessed.

In 1985, a cooperative DOE/industry program was initiated through a Memorandum of Agreement with the Electric Power Research Institute (EPRI). The objective is to assure that the lessons from U.S. past experience have been successfully applied to these new mid-sized and large LWR designs. Through the cooperative efforts of the NRC, DOE, EPRI, utilities, and suppliers, the way can be paved to complete the development and acceptance of both large and mid-sized advanced LWR's as attractive energy options for the future.

In FY 1986 and FY 1987, DOE--through competitive contracting and in cooperation with EPRI--will be providing selected technology support for these advanced designs. The important factors that will be considered in determining DOE support include the degree to which system design improvements reduce the sensitivity of plants to transients, enhance safety margins, improve use of

passive safety features, simplify systems to reduce the need for regulatory involvement or oversight, improve the quality of construction, and develop a technical and regulatory basis for improved plant control. I am pleased to report that an initial selection of technical proposals has been made. Considerable industry interest was expressed in participating in a cost-shared program that will explore innovations in LWR technology to help assure that future nuclear power plants can be built on schedule, within budget and conform with the degree of safety and reliability that our citizens have every right to expect.

THREE MILE ISLAND R&D

FY 1986 R&D activities for the damaged TMI Unit 2 (TMI-2) reactor indicate successful movement by the GPU Nuclear Corporation, the nuclear industry, and government toward completing the objectives of the TMI-2 program. Defueling of the reactor has begun and shipments of core debris will be shipped to DOE's Idaho National Engineering Laboratory (INEL) for examination and storage. The current schedule calls for completion of fuel removal from the original core region by the end of FY 1986 and removal of the remaining fuel from the bottom of the reactor vessel and from the primary system components by the end of FY 1987. Data acquisition--a key element of the Department's TMI R&D effort--will focus on instrumentation and equipment performance, severe accident analyses including the behavior of radioactive fission products, data system and sample archiving, and offsite fuel

debris examination. EPRI is providing mechanisms to assist in transferring this technology to industry.

Efforts in FY 1987 will be to conduct the offsite examination of the damaged TMI-2 reactor core at INEL and to transfer the technology to industry. The core examination will provide unique information on full-scale reactor behavior during severe accidents. This work will provide the necessary data for evaluating present licensing criteria and requirements; developing future licensing criteria; and assessing and developing computer models that are necessary to analyze the course and consequences of severe accidents in order to mitigate the effects of such accidents. This program will be completed in FY 1988.

ADVANCED REACTOR RESEARCH AND DEVELOPMENT

At the request of the Secretary, the Energy Research Advisory Board (ERAB) convened a Civilian Nuclear Power Panel in October 1985 to review and comment on the Office of Nuclear Energy's draft Strategic Plan for Civilian Reactor Development. The essence of the draft Strategic Plan is to establish an agenda of requisite actions and tasks to develop advanced reactor systems that can be acceptable and competitive in a future market. While the pace of the program to fulfill that agenda must be adjusted to accommodate national priorities and funding constraints, it is the Department's intent to continue to operate our unique liquid metal reactor test facilities and to conduct the R&D leading to

licensing and potential commercial deployment of advanced reactor systems at an appropriate time in the future. A revised Strategic Plan, based on consideration of comments received from the ERAP Panel, Congress, and others, will be valuable in guiding and focusing DOE's reactor development programs, in helping ensure complementary efforts by the private and public sectors, and in maintaining goals and objectives to ensure effective utilization of public funds.

In FY 1986 work will continue on the development of LWR and HTGR designs and their supporting R&D activities. These designs emphasize competitive economics, greater reliance on passive safety, increased tolerance to off-normal events, improved licensability, and shorter construction times. This advanced reactor systems program is aimed at providing alternative means of economic electricity production in the future, including the use of breeder reactors when the market dictates. Advanced plant design activities are placing emphasis on refining system concepts and plant arrangements. Evaluations are being conducted to enhance the ability of these designs to meet these objectives. FY 1987 will see a further focusing of our efforts on key economic and safety aspects of these designs.

Reviews of the advanced designs and licensing interactions have been conducted by NRC, and responses have been received regarding the innovative safety approach adopted for these designs. Safety analyses are being prepared for both the HTGR and LWR designs and will be submitted to the NRC by the end of FY 1986 to support the

preparation and issuance of a Preliminary Safety Information Document, which will be the basis for a formal opinion by NRC concerning licensability.

R&D support is being conducted in the areas of long life metal and oxide fuels, materials, advanced component development, development of passively safe reactor shutdown and heat removal systems, advanced plant control systems, inherently safe core designs, and core modification to meet specific program needs. Test support at our facilities is being provided in the areas of long-life core development, inherent safety testing, seismic response, thermal/hydraulic analysis, and system transients.

The advanced reactor program for FY 1987 and beyond builds on the substantial progress made by advanced reactor technology and design R&D over the years. The most important elements of the existing program, including some international activities, are retained, while a portion of the technical capability of the laboratories and test facilities is made available for use in pressing near-term space and defense applications. Safety systems design, advanced fuel cycle concepts, and plant technology R&D are important elements.

Passive safety features are being incorporated into the advanced reactor designs and will reflect advances being made in fuels and core designs. This will significantly reduce the likelihood and consequences of plant failures. Key related activities will be the completion of transient tests in the Fast Flux Test Facility (FFTF) and transient overpower tests in the Experimental Breeder

Reactor II (EBR-II). The safety systems design activity incorporates the integration of state-of-the-art technology in communications, controls, and operations into advanced reactor designs. Work next year will include development of man/machine interface criteria and testing methodology for civilian power, space and defense reactor needs. The advanced fuel cycle activities will continue the progress made towards the objective of extending core life to at least 3 years. The potential exists to achieve much longer core lifetimes with attendant economic benefits. Metal fuels work will be directed to establishing technical feasibility and potential to improve safety margins, fuel cycle costs, and improved proliferation resistance.

The plant technology efforts are focused on supporting the design of a standardized, modular plant that can be shop fabricated. Studies of advanced concepts have shown that standardization can eliminate up to 80 percent of indirect engineering costs. Modularity and shop fabrication are expected to provide labor cost savings. The FY 1987 R&D program will include activities in the areas of seismic/shock testing, fuel performance testing, passive decay heat removal, core thermal-hydraulic testing, circulator/pump development, and plant and rod control systems and materials.

Cooperative testing, design, and analytical programs on the breeder and other reactors with European nations and Japan are being continued, including private sector interactions, in the

areas where the applications of results serve our prospective advanced commercial reactor needs.

The advanced civilian reactor development program has embarked on a course destined to develop advanced nuclear systems that meet market demands. Our rate of progress on that course must be tempered by fiscal constraint. However, we have made important progress and our resolve to meet our objectives is undiminished.

SPACE AND DEFENSE NUCLEAR POWER SYSTEMS

The Space and Defense Power Systems program is structured to respond to requirements identified by the National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD), including the Strategic Defense Initiative Organization (SDIO). Program activities will provide the design, development and supporting technology for building compact, high performance reactors for space and terrestrial applications and dynamic isotope power systems for space application. This work is divided into the SP-100 Space Reactor Project, the Multimegawatt Space Nuclear Power Program, the Dynamic Isotope Power System (DIPS), the Small Nuclear Power Source (SNPS) Demonstration Project, and the Multimegawatt (MMW) Terrestrial Nuclear Power Program. A discussion of each follows.

SP-100 SPACE REACTOR PROJECT

The SP-100 Program was initiated in February 1983, when DOE, NASA, and the Defense Advanced Research Projects Agency (DARPA)

formally agreed to jointly investigate, fund, and--if warranted--develop Space Reactor Power System Technology. The SP-100 Program is a three-phase effort.

Phase I (Technology Assessment and Advancement, FY 1983-1985) involved the investigation of concepts, the assessment and advancement of critical technologies, the establishment of technical and safety feasibility, and the selection of one power system concept for further engineering development and ground demonstration testing at a selected DOE test site during Phase II. This phase was successfully completed in FY 1985.

Phase II (Technology Flight Readiness, FY 1986-1991) involves civil and military mission analysis and requirements definition; detailed design, engineering development, and ground testing of the selected power system concept to demonstrate its safety, performance, dependability, and readiness for dedicated flight use; and pursuit of even more advanced aerospace technology which could further enhance an SP-100 system in the longer term.

Phase III (Flight System Production, Qualification, and Flight Demonstration/Application, approximately FY 1991-1993) will involve flight system fabrication; ground-based flight qualification testing; spacecraft and launch vehicle integration; launch; and actual space flight demonstration/application.

Phase I efforts culminated with the selection of a concept for further engineering development and demonstration testing during Phase II. The selected concept employs a compact, liquid metal

cooled, fast-spectrum reactor with out-of-core thermoelectric power conversion. It will be designed, built, and tested at a reference power of 300 kilowatts electric (kWe). In November 1985, DOE selected the Hanford, Washington, facility as the preferred site at which to conduct the reactor ground demonstration testing.

A Request for Proposals (RFP) was issued in November 1985 to secure a system development contractor from industry by September 1986. That contractor will be responsible for designing, fabricating, and directing the ground testing of a prototype space reactor and other key subsystems. This effort will involve analysis and testing sufficient to demonstrate system performance, safety, dependability, and flight readiness. As an option, this effort additionally includes the provision to produce flight units and provide all the support necessary to expedite a flight program when the initial user commitment is finalized.

Programmatically, a Memorandum of Agreement to establish, manage, and implement the Phase II technology flight readiness program was signed by DOE, DOD, and NASA in early October 1985. Specifically, DOE is responsible for the ground engineering system development. The SDIO is responsible for overall program direction and--with the Air Force as its executing agent--military mission analysis and requirements definition. NASA is responsible for civil mission analysis and requirements

definition, as well as for advanced aerospace technology that could ultimately enhance an SP-100 system.

A planned 300 kWe SP-100 nuclear electric propulsion flight demonstration for SDIO in the early 1990s timeframe was established in September 1985. This reference mission will serve to demonstrate and flight qualify SP-100 for follow-on dedicated mission use. Preliminary reference mission planning will be completed in mid-1986. Funding for this planned flight demonstration has been programmed by the SDIO in their outyear budget projections starting with FY 1987.

The Department is committed to the SP-100 Ground Engineering System (GES) development and testing project as are our other SP-100 partners. Its success will provide a new energy option to mission users in the 1990's and beyond.

MULTIMEGAWATT SPACE NUCLEAR POWER PROGRAM

The need for powerful new, space-based defense weapons and surveillance systems for protection against the threat of nuclear missiles has been established as a top national priority. The proposed weapons and surveillance systems require large amounts of electrical power, significantly more than can be provided by current power systems.

The SDIO has established a program to develop nuclear and nonnuclear systems that can separately or in combination meet the SDI multimegawatt power requirements. Responsibility for

developing nuclear power system concepts and technology has been assigned to DOE. The Air Force has been assigned responsibility for nonnuclear power systems development.

A key objective of the MMW Space Nuclear Power Program is to identify and develop at least one space nuclear power system concept by 1991 that alone, or in combination with a nonnuclear power system, meets SDI MMW power requirements and for which technical feasibility issues have been resolved.

To meet the SDI requirements for safe, reliable, compact MMW power sources, significant advances in space nuclear power technology must be achieved. SDI missions such as space-based defense weapons, imaging radars and electric propulsion have high electrical power requirements: hundreds of megawatts for up to 2,000 seconds (burst mode) for some weapons; tens of megawatts for up to 1 year total operating time (alert mode) for imaging radars, weapons readiness, and electric propulsion; and hundreds of kilowatts to a few megawatts for as many as 7 years (continuous mode) for station-keeping activities and surveillance.

During FY 1985 and FY 1986, the program focus has been on developing a MMW Space Nuclear Program Plan and on assessing and investigating various system concepts and related critical technology areas that must be advanced if these reactor system concepts are to be able to meet the power, mass, volume, and longevity requirements of the SDIO. The program plan addresses system requirements, and provides concept and technology

overview, program strategy, costs, schedules and milestones, as well as concept and technology developing activities. Work under the plan was initiated in FY 1986.

The FY 1987 effort will continue the evaluation and development of potential multimegawatt space power concepts. In addition, work will continue on experimental testing and development of key enabling technologies that are required if the preferred concepts are to become fully viable. These experimental testing and development efforts will focus on advanced nuclear fuels, materials, safety, and reliability. Advanced reactor control techniques and neutronics, shielding and thermal hydraulic codes will also be developed.

DYNAMIC ISOTOPE POWER SYSTEM

The needs of military spacecraft in the planning process include higher power requirements and increased survivability to threats directed at disablement or destruction of the space system. The current standard spacecraft power source, arrays of photovoltaic cells, lacks required features of hardness and has too much volume that could constrain the maneuverability of these new space systems. One class of spacecraft of current interest for high priority missions, requires power in the range of 1 to 10 kilowatts of electrical power; stringent attitude control and station keeping; and survival from the threats projected for the 1990 time period. In order to make certain that a highly reliable and efficient isotope powered system in the one to ten

kilowatt electrical range is a viable option for military planners, a joint DOD/DOE program is being initiated.

The dynamic isotope power system (a combined turbine alternator, isotope-fueled power subsystem) is an enabling technology for these military space missions which require survivability against various threats, higher power missions performance, and a small power supply to improve the spacecraft sensors field of view and overall spacecraft pointing accuracy. DOD missions such as the Boost Surveillance and Tracking Systems (BSTS) are currently under active mission requirements definition and analysis as part of the SDI program. All of the DOD contractors have recommended the DIPS as the primary power source for the BSTS application.

The goal of the DIPS program is to develop and demonstrate the necessary technology required to provide this type of space electrical power in the range of one to ten kilowatts output for use by these types of emerging military space missions in the mid-1990's and beyond. The specific objective of this development program is to develop the DIPS as a viable enabling technology as the electrical power supply for the SDI space surveillance spacecraft.

SMALL NUCLEAR POWER SOURCE DEMONSTRATION PROJECT

There is a military, and potentially a civilian, need for ground-based power systems that can operate continuously in harsh environments with minimum attendance and freedom from the need for frequent replenishment of fuel supplies such as diesel oil.

These systems must have high reliability, low maintenance, long lifetimes, and simplified logistics. Nuclear reactor technology appears to offer feasible and improved alternatives to conventional power systems for such applications as the North Warning System, which is the upgrade of the Distant Early Warning (DEW) line across northern Canada.

Because of the logistics and resupply costs of maintaining diesel generators a reactor power system is being considered as an alternative. Such a reactor system would require only minimum maintenance, and it would potentially result in significant savings in operation and maintenance costs and in overall life cycle costs. An assessment of the concept was undertaken in FY 1984. Based on the positive findings of that assessment, conceptual design efforts on reactors for the North Warning System (now called the Small Nuclear Power Source Demonstration Project) were initiated in FY 1985. The Department of Energy, the United States Air Force (USAF), and Atomic Energy of Canada, Limited (AECL), are jointly funding a program to investigate and demonstrate the feasibility of using a 15 kWe reactor power source for an application such as the North Warning System. In FY 1986, the design is being completed, component development testing is underway, and the demonstration reactor is being fabricated.

In FY 1987, zero power tests will be conducted on the nuclear and heat pipe subassemblies to verify the neutronics performance of the subsystem. The complete system will be installed in a test

cell at AECL's Whiteshell facility and system startup tests will be initiated in early FY 1988.

Basically, all of the system components use state-of-the-art technology that has been used in other systems. For example, the nuclear fuel will consist of pellets of the type used in high-temperature gas-cooled reactors, and the organic rankine cycle will be similar to those used on fossil-fueled generators for communications on the Alaskan oil pipeline and for waste heat recovery on several industrial processes. The initial objective of the program is to place a demonstration reactor in ground testing by late FY 1987.

MULTIMEGAWATT TERRESTRIAL NUCLEAR POWER PROGRAM

In response to interest by the Air Force (as well as SDIO) an effort is underway which will lead to the design of a hardened nuclear powerplant with a nominal 10 MWe rating. This plant will feature a passively safe design, a capacity factor in excess of 90 percent, refueling intervals which could range from 4 to 10 years, and will be hardened against specified military threats.

The SDIO has expressed interest in such a nuclear powerplant for its ground-based applications. These applications include the command, control, and communications systems that must operate reliably in a hostile environment if the total SDI system is to be credible. The source of power for these systems must be relatively invulnerable to terrorism, sabotage, and

electromagnetic pulses from high altitude nuclear detonations as well as to acts of nature, e.g., lightning strikes, snow, windstorms. As the SDI system emerges, it is possible that a significant portion of the detection and weapon systems will be ground-based rather than space-based; these systems will need power supplied from dedicated, secure, and reliable powerplants.

Conceptual design studies of a secure military nuclear powerplant have been performed and found to show that the concept is sound. A request for proposal for advanced design of the plant has been prepared. In late FY 1986 up to two concepts will be selected for detailed design; the preliminary design will be completed by the end of FY 1987.

ADVANCED NUCLEAR SYSTEMS

The responsibility of the Advanced Nuclear Systems program is to develop, demonstrate, and deliver radioisotope power sources for U.S. military and civilian space and terrestrial missions. A recent dramatic application of RTGs was the Voyager 2 fly-by of Uranus--a planet so far from the Sun that it receives less than 0.3 percent of the sunlight received at Earth. In such a region of dark space, nuclear power is the only option for planetary explorers. The RTGs on Voyager 2 are still performing well above the prelaunch predictions over eight years after launch. NASA plans to continue to use RTGs on their next generation of planetary explorers (Mariner Mark II) planned for the 1990s.

Today, RTGs have been built with power levels over 300 watts, so that several could be ganged to provide up to a kilowatt or more of electrical power. Recognizing the usefulness of isotope power, DOD and DOE signed an umbrella agreement in 1985 to foster work on isotope power systems. A supplemental agreement has been prepared to support the BSTS. In cooperation with the Air Force, DOE is planning to develop the dynamic isotope power system for BSTS. However, current Air Force plans call for flying an early BSTS flight experiment to test out the system. Because the flight experiment may require less power than the operational satellites, RTGs are a logical choice to provide dependable, survivable electrical power.

A major effort under the RTG program has been the design, fabrication, and delivery of isotopic power supplies, safety analyses, and planning of launch support activities for the NASA Galileo and Ulysses missions. The four General Purpose Heat Source (GPHS) flight RTGs, including one spare, and 118 radioisotope heater units for thermal control of spacecraft components, have been delivered. Following these mid-1987 NASA launchings, DOE will support the mission by continued testing of the qualification and engineering units of the RTGs, analyze RTG mission performance data, and provide NASA with periodic long-range predictions for mission planning.

In looking forward to future NASA and DOD space missions, DOE is continuing to pursue the technology and the development of an advanced RTG that offers promise of higher power density and

greater size adaptability as mission requirements change. The Orbital Servicing Demonstration (OSD) will enable OMV to accommodate a range of intermediary missions identified by the Solar System Exploration Committee of the NASA Advisory Council. The OTV is also a potential power source for the experimental flight of the SEP for the ESI program. In parallel with the OTV development, MSFC is continuing its efforts to improve thermoelectric conversion efficiencies, including silicon germanium optimization, electrical contacting, evaluation of materials properties, degradation mechanisms, and material interactions.

To respond to future STV delivery requirements, it is essential that DOE not only maintain a viable heat source production capability within its laboratory structure but also continue these efforts necessary to improve heat source safety, improve production efficiency to reduce heat source costs, and continue work in long-lead areas. In FY 1987, the Mound Laboratory (Mound) near Miamisburg, Ohio, will begin the facility and various modifications for the assembly and loading of a mission representative STV delivery to GEO in late 1988. Also in 1987, Mound will start the design and safety modifications process for a small, reduced, heat source needed for the Special Applications program. We plan that the Los Alamos National Laboratory (LANL) will continue the heat source materials program, where improved processes and testing techniques show promise of lower cost over the heat source isotope encapsulating material.

To meet our obligations to deliver low-wattage RTGs for terrestrial military missions, the Special Applications program will continue its efforts to develop and demonstrate the necessary technology. During 1987, an RTG demonstration system test will be continued to verify long-term performance predictions. Also, thermoelectric modules of primary and alternate designs will be tested under selected environmental conditions to support RTG performance predictions and reliability analyses.

FACILITIES

DOE and its contractors operate some of the most advanced and sophisticated nuclear test facilities in the world today for advanced power generation reactors, fuels, components, and materials. The facilities provide unique testing capabilities required for the development of safe, reliable, environmentally acceptable and efficient nuclear energy power sources that will be suitable for civilian power generation, space, and military applications. These facilities are also used in the development of fusion technology; cooperative technology programs with other countries; non-nuclear energy programs such as coal, solar, and geothermal; and conducting tests for other Government and private sector organizations such as EPRI and the NRC.

These facilities include the DOE irradiation facilities--the ORR-II, the Transient Reactor Test (TREAT) facility, the Zero Power Plutonium Reactor (ZPPR), and support facilities at the

Argonne National Laboratory near Idaho Falls, Idaho (ANL-West); the FFTF at the Hanford Engineering Development Laboratory (HEDL) near Richland, Washington; and the comprehensive non-nuclear liquid metal component test complex at the Energy Technology Engineering Center (ETEC) near Canoga Park, California. At the heart of the facility capability are experienced engineers, scientists, technicians, and operators. In recent years, the program has markedly improved the efficiency of its facilities. Non-essential facilities have been shut down and operations of remaining facilities have been improved. This effort is continuing in order to assure that this essential activity is carried on at the lowest possible cost.

The accomplishments and activities of our facilities and test programs are significant and include: (1) the FFTF has achieved a world record for continuous operation of an LMR at full power (101 days), demonstrating the outstanding reliability of LMR's; (2) fuel performance in the FFTF has gone well beyond the burnup goal of 80,000 megawatt days per metric ton; (3) successful testing in the FFTF of inherent safety features and advanced control concepts; (4) the recent successful completion of a loss-of-flow without reactor scram test from 100 percent power in the EBR-II, which further attests to the passive safety capability of liquid metal cooled reactors; and (5) testing at ETEC is currently making significant contributions to LMR designs resulting from their natural circulation tests, advanced shutdown heat removal tests, and performance testing of advanced steam generators. Continued operation of FFTF, EBR-II, and ETEC

continues to contribute to U.S. liquid metal reactor operating experience.

In FY 1987, the facilities will continue to support the changing civilian, military and space nuclear power requirements. Civilian advanced reactor concepts will require special tests for evaluation of fuels performance and reactor dynamics. Irradiation testing is assuming a more critical position in analysis of materials and fuel performance for military and space reactor applications.

The test programs planned for FY 1987 include reactor safety and fuel performance and component testing for advanced reactor concepts, irradiation of candidate core materials for space reactor use, irradiation of SP-100 fuel and cladding, run-beyond-cladding breach, operational transient testing under the joint United States/Japan Cooperative Program, irradiation of material specimens for the United States and Japan, and fusion programs and tests supporting reactor plant simplifications and cost reduction features.

The Department plans to evaluate the current methods by which users share in facility costs. Alternative cost-sharing approaches will be evaluated for partial implementation in FY 1987, with fuller implementation planned for FY 1988, if practical. Facility operations are directed toward conducting required tests to support and verify advances in fuels, core systems, materials, safety, components, and instrumentation and

control systems to meet civilian, defense, and space nuclear energy requirements.

WATER COOLED BREEDER REACTOR TECHNOLOGY

One of the variations of advanced nuclear technology is the use of a uranium-233/thorium fuel cycle. The Water Cooled Breeder Reactor program has the mission of developing technology that will significantly improve the efficiency of utilizing nuclear fuel resources. The specific objective is to prove that fuel breeding can be achieved in a light-water reactor using the uranium-233/thorium fuel system. The focus of program efforts in FY 1987 will be to complete evaluation of the light-water breeder core removed from the Shippingport Atomic Power Station to verify breeding, thereby bringing this project to its planned conclusion in FY 1987.

REMEDIAL ACTION AND WASTE TECHNOLOGY

The objectives of the Remedial Action and Waste Technology Program are to treat or stabilize radioactive wastes and perform decontamination and decommissioning at contaminated DOE and legislatively-directed non-government facilities and sites; help facilitate development of a reliable national system for managing low-level radioactive wastes; and develop acceptable technologies for the treatment and immobilization of nuclear wastes. Successful execution of this program is a key part of the Department's commmitment to continue to protect public health and

safety and to assure a safe and clean environment in connection with its activities.

The major Remedial Action and Waste Technology activities are: (1) the Formerly Utilized Sites Remedial Action Project (FUSRAP); (2) remedial action at Grand Junction, Colorado (Public Law 92-314 as amended); (3) the Uranium Mill Tailings Remedial Action Project (UMTRAP) for inactive uranium mill tailing sites (Public Law 95-604); (4) the Surplus Facilities Management Program (SFMP), for certain radioactively contaminated DOE facilities declared surplus and resulting principally from civilian nuclear energy programs; (5) demonstration of the solidification of high-level radioactive wastes at West Valley, New York, for final disposal (Public Law 96-368); (6) technical assistance to States and regions to assist them in developing new capacities for the disposal of low-level radioactive waste, in accordance with Public Law 96-573, the Low-Level Radioactive Waste Policy Act, and Public Law 99-240, the recently enacted amendments to this legislation; (7) development of nuclear waste treatment processes and waste forms suitable for transportation, storage, and ultimate disposal in a geologic repository; and (8) civilian byproducts utilization and applications with primary emphasis on food irradiation.

The requested funds for the Remedial Action and Waste Technology Program are distributed among the program elements as indicated in the following table.

Program Element	--($ in Millions)-- FY 1986 Estimate	FY 1987 Request
Remedial Action and Waste Technology		
Formerly Utilized Sites	$ 18.9	$ 25.6
Grand Junction	0.9	0.8
Uranium Mill Tailings	91.3	126.0
Surplus Facilities	39.9	56.4
West Valley	61.6	79.0
Low-Level Waste	4.6	4.0
Waste Treatment	6.2	0
Byproducts Utilization	4.8	0
Program Direction	1.8	2.3
Total	$230.0	$294.1

This increase in our FY 1987 funding request is consistent with prior year projections as we move from largely planning and engineering activities into the execution phases of major projects in the next 3 years. In light of fiscal constraints, this increase is less than planned, achieved through a stretch-out of the UMTRA program discussed in more detail below.

FORMERLY UTILIZED SITES REMEDIAL ACTION PROJECT

FUSRAP provides for remedial actions at former nuclear processing facilities which became radioactively contaminated as a result of former Manhattan Engineer District or Atomic Energy Commission (MED/AEC) activities and which have not been decontaminated sufficiently to meet current public health and safety guidelines. FUSRAP also includes certain contaminated sites specifically assigned to DOE by Congress for remedial action.

To remedy the situation at these contaminated sites, either the contaminated material will be stabilized in place, with

restrictions placed on the use of the site, or the contamination will be removed and disposed of at another location. Authority currently exists, derived from the Atomic Energy Act of 1954, for conducting remedial actions at 24 sites, based on a review of the involvement of the Department's predecessor agencies in activities at these sites. In 1985, this review process led to the addition, by the Department, of the following 4 sites (included in the total of 24 cited above) to the project: (1) former Bridgeport Brass Company, now a General Motors property (Adrian, Michigan); (2) former Bridgeport Brass Company, now Seymour Wire Specialty (Seymour, Connecticut); (3) National Guard Armory (Chicago, Illinois); and (4) former Metal Hydrides, Incorporated, now Ventron Division of Thiokol Chemical (Beverly, Massachusetts). Review of other sites involved in past activities of the Department's predecessors is continuing and is scheduled to be completed in 1987. This review may result in the addition of other sites to the program.

Congress added four sites in the FY 1984 Energy and Water Development Appropriations Act (Public Law 98-50), with direction to initiate a decontamination research and development project at these sites as a priority action. In the FY 1985 Energy and Water Development Appropriations Act (Public Law 98-360), Congress directed DOE to acquire the former St. Louis Airport site and use it to dispose of waste from cleanup of the nearby Latty Avenue site and vicinity properties. Congressional and Departmental additions bring the total number of sites in the project to 29.

The Department's Oak Ridge Operations Office has the lead role in implementing the Formerly Utilized Sites Remedial Action Project.

In FY 1985, the cleanup of the contaminated central drainage ditch leading from DOE-owned Niagara Falls Storage Site at Lewiston, New York, was completed for a distance of about 1 1/2 miles. In FY 1986, the Department expects to complete cleanup work at the remaining four contaminated properties near this site. Work will be completed on the installation of an interim cap on the waste storage area, about 9 months later than originally planned. This delay was due to technical problems in transferring the radium-contaminated residues from a concrete tower to a storage location and in treating large quantities of impounded water to meet stringent State standards for discharge. Other remedial actions at this site are described under the Surplus Facilities Management Program.

The Department is planning to complete the remedial actions at the Middlesex Landfill in New Jersey in FY 1986 that were about 50 percent completed in FY 1984. No cleanup work was done on this site in FY 1985. This is about 21 months later than originally planned, due to a large increase in the estimated volume of contamination and the higher priority assigned to the Maywood, New Jersey, remedial action.

Decontamination actions begun in FY 1984 and continued in FY 1985 are underway in FY 1986 at Maywood, New Jersey; Wayne, New Jersey; and Colonie, New York. The general approach to these projects is to give priority to the cleanup of contaminated

residential properties and to store the waste temporarily on each processing and storage site. The cleanup of residential properties in Maywood, contaminated with material from the Stepan Chemical Company site, was completed in FY 1985, along with some residential properties found to be contaminated from the Stepan site in the adjacent town of Lodi. The contamination from the Stepan site has been found to be more extensive, extending into Lodi and under New Jersey Route 17. In FY 1986, cleanup of one Maywood commercial property continues. Extensive characterization of the contaminated areas and engineering for further remedial actions will be completed. The waste from this site is being stored on an 11.7 acre part of the Stepan Company property at Maywood which Stepan donated to DOE in 1985 along with $580,000. The storage pile was expanded in 1985 and modified to meet State requirements. The Department expects to complete a study of options for permanent disposition of the more than 270,000 cubic yards of waste later this month.

At Wayne, New Jersey, the cleanup of a ball field and a bus yard was completed in FY 1985, interim stabilization of the waste on site was begun, and onsite monitoring wells were installed. In FY 1986, about one-third of the cleanup of Sheffield Brook and cleanup of residential properties bordering the brook will be completed. Modifications are being made to the site so that wastes can be stored on the site temporarily. The site is considered unsuitable for permanent stabilization because of ground water flow. The State of New Jersey has been requested to nominate candidate locations in the State for DOE to establish a

site for disposal of the estimated 50,000 cubic yards of waste at Wayne, as well as the other estimated 360,000 cubic yards of FUSRAP waste at Middlesex and Maywood.

At Colonie, New York, DOE acquired the NL Industries site as a donation in February 1984, along with two adjacent parcels owned by the Niagara Mohawk Power Company that have waste buried on them. Radiological surveys of a total of 130 vicinity properties have been completed through FY 1985, and of these, 54 properties need remedial action. About 90 to 100 additional properties remain to be surveyed. Cleanup of 35 properties was completed by October 1985 (11 in FY 1984 and 24 in FY 1985) and all remaining properties will be completed by October 1987. The contaminated soil is being temporarily stored inside the plant. Later this month we expect to complete a study of options for the permanent disposition of the more than 30,000 cubic yards of waste. The State has been requested to nominate candidate locations for a DOE disposal site in New York. In FY 1986, DOE will remove the radioisotope sources from the plant previously used for inspection work as well as hazardous chemicals in the plant.

At Hazelwood, Missouri, DOE has arranged with the site owner, Futura Chemicals Company, to use a part of the site for storage of contaminated soil. Cleanup of a portion of Latty Avenue, adjacent to the Hazelwood site, was initiated in FY 1984 and was completed in FY 1985. Border areas on the site were cleaned up to prevent recontamination of Latty Avenue, and fencing was installed around the site. Radiological surveys of the vicinity

installed around the site. Radiological surveys of the vicinity properties were performed in FY 1985, and a survey of the developed part of the Latty Avenue site will be started in FY 1986. Cleanup activities on the remaining vicinity properties will not be started until the waste can be moved to the St. Louis Airport Disposal site. The City of St. Louis, Missouri, is considering the terms of transfer of the former St. Louis Airport Storage site to the Department for use in disposing of the estimated 60,000 cubic yards of waste from the Hazelwood site and vicinity properties, as required by language contained in the report that accompanied the FY 1985 Energy and Water Development Appropriations Act (Public Law 99-360). In FY 1985, DOE installed a 300-foot rock wall (gabion) at the Coldwater Creek bank of the Airport site to prevent erosion from spreading contamination into Coldwater Creek. In FY 1986, further site characterization (radiologic and geologic) work will be started and this work will be completed in FY 1987. Preliminary design work, initiated in FY 1986, will be completed in FY 1987.

A revision to the FUSRAP Project Plan was completed in FY 1985. A preliminary total cost estimate of $675 million has been made for the FUSRAP scope, consisting of 25 sites, based on completion of all the work by the year 2001. The Plan will be updated in FY 1986 to include the four additional sites added by the Department in FY 1985.

GRAND JUNCTION REMEDIAL ACTION PROJECT

Under Title II of Public Law 92-314, Congress authorized financial assistance to the State of Colorado to limit radiation exposure resulting from the use of uranium mill tailings for construction purposes in Grand Junction, Colorado. This State and Federal cooperative effort is administered by the Colorado Department of Health through DOE's Grand Junction Area Office. The remedial action provides for removal of uranium mill tailings from the premises of an estimated 981 structures where concentrations of radioactive radon and its decay products exceed guidelines established by the Surgeon General. Public Law 95-226 extended the time, which has now expired, for property owners to apply for inclusion and also increased the authorized funding for the program. Federal funds cover 75 percent of the program costs, with the State providing the balance. Contingent upon the availability of adequate funding from the State of Colorado, the remedial action is expected to be completed in FY 1987, with final radiological verification to be completed in FY 1988.

At the end of FY 1985, work had been undertaken on 546 structures. In FY 1986, radiological assessments will be continued, engineering on all properties will be completed, and remedial actions will be initiated at 20 additional structures, including 17 residences, 2 commercial establishments, and 1 church. In FY 1987, work is scheduled to be undertaken on 15 properties, including 6 commercial structures, bringing the

total number of properties completed to 581 out of the estimated total of 583.

TRAILS HILL RAILROAD REMEDIAL ACTION PROJECT (RAPROAD)

RAPROAD is responsible for conducting remedial action at 24 former uranium ore processing sites and several thousand contaminated vicinity properties, as mandated by Public Law 95-604, the Uranium Mill Tailings Radiation Control Act of 1978. Nine of the sites are designated as high priority, six as medium priority, and nine as low priority. The Act provides authority for remedial action by the Department for a period of 7 years following promulgation of standards by the Environmental Protection Agency (EPA), which occurred in March 1983.

The Department is proposing to extend the Trails authorization period until the end of FY 1991, consistent with the recommendation to extend the duration of the projects made by the House Appropriation Committee in House Report No. 98-282 accompanying the FY 1984 Energy and Water Development Appropriations Act (Public Law 98-141). The FY 1987 budget request identifies resource requirements to meet this extended schedule. The proposed extension takes into consideration the actual project experience gained in performing remedial action at several processing sites and many vicinity properties. Project plans have been revised to reflect this experience, and are based on the following key assumptions: (1) 4,830 of the 8,156 designated vicinity properties will actually require clean-

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[redacted]

Specific accomplishments in FY 1993 included the completion of 80 percent of the remedial action at Canonsburg, Pennsylvania, and initiation of remedial action at Salt Lake City, Utah; and Shiprock, New Mexico. The implementation of the remedial action at the Salt Lake City processing site has been assigned to the State of Utah. The approach at this site is to relocate the tailings to a site near Clive, Utah. Cleanup continued at high-priority vicinity properties near the sites at Canonsburg, Pennsylvania; Salt Lake City, Utah; Grand Junction, Colorado; and Edgemont, South Dakota; and started at Shiprock, New Mexico; Riverton, Wyoming; and Durango, Colorado.

During FY 1994, work is underway or planned at five processing sites. The Canonsburg project will be completed early in the fiscal year. The work at Salt Lake City will be brought to an estimated 70 percent of completion, and the work at Shiprock will be 80 percent completed. Onsite work will be started at the processing sites at Tuba City, Arizona, and Lakeview, Oregon. Many off-vicinity properties located at several high-priority sites will also be decontaminated.

<u>During FY 1995, remedial action will be underway at 7 processing sites and 800 vicinity properties.</u> The work at Shiprock, New Mexico, and Salt Lake City, Utah, will be completed. Work will continue at Tuba City, Arizona, and Lakeview, Oregon. Processing site remedial action will be started at Durango, Gunnison and Grand Junction, Colorado; Riverton, Wyoming; Bekeesie Lake, New Mexico; and Monticello, Utah.

SURPLUS FACILITIES MANAGEMENT PROGRAM

This program provides for the safe management and disposition of certain surplus radioactively contaminated DOE-owned facilities from nuclear energy development activities. The decontaminated facilities and sites are to be returned to other productive use, where appropriate. (Similar actions at defense-related facilities are separately budgeted as Atomic Energy Defense Activities.) The facilities are grouped into 33 projects under this activity. This number increases by one for FY 1987 because the Department will assume the responsibility for decommissioning the Power Burst Facility in Idaho, formerly supported by the NRC. A long-range plan was completed in April 1985 to establish the overall schedule and priorities for sites currently in the surplus inventory. Priorities are established and work schedules are developed through analysis of public health and safety, legal, economic, and work continuity factors for each site. The Department's Richland (Washington) Operations Office has the lead role in implementing this program.

In FY 1985, the major onsite cleanup and upgrading of the interim storage cell was continued at the Niagara Falls Storage Site in Lewiston, New York. The remainder of the 4,000 cubic yards of residue stored in a 165-foot tower were transferred through a 3/4-mile pipeline and were excavated from the tower to a low concrete building at the waste storage area. The tower was demolished and the contaminated rubble was moved to the storage cell. A thick clay cap with a design life of greater than

25 years is being placed over the wastes to minimize water infiltration. Installation of this interim cap is scheduled for completion by the end of FY 1986. A Final Environmental Impact Statement (EIS) on the long-term management for this site is to be issued in FY 1986. In FY 1987, only surveillance and maintenance of the Lewiston site is planned. Since all offsite and onsite contamination will have been consolidated into the monitored and controlled storage cell, there will be no urgency from a health viewpoint to proceed with implementation of the long-term management option. This work will be deferred to use available funds for higher priority work.

Work on the decontamination of plutonium-contaminated facilities at Mound Laboratories will be continued in FY 1986 and FY 1987 and completed in FY 1988. This 11-year project was begun in 1978 and will continue through planned completion as a high priority.

Decommissioning of the Shippingport Atomic Power Station is another major DOE project. Following defueling of the reactor at the end of FY 1984, physical dismantling of the plant began in FY 1985. Preparations for removal of major components were begun, and some noncontaminated buildings were demolished. Dismantling of portions of the plant will continue in 1986 and 1987 and is scheduled to be completed in FY 1990. Preparation for the removal of the reactor pressure vessel will begin in FY 1987; the vessel is scheduled to be barged to the Department's Hanford Reservation near Richland, Washington, for disposal in FY 1989. The Department is cooperating with the NRC and EPRI in

obtaining samples of the pressure vessel for aging studies. Other components will also be examined for this purpose. The Department is participating in a Nuclear Energy Agency-sponsored international exchange of decommissioning technology, which includes Shippingport, West Valley, and eight significant projects in other member countries.

In FY 1985, the Department continued interim site maintenance and monitoring as well as engineering and planning for the Weldon Spring Site Remedial Action Project in Missouri, a major DOE project. In addition, a Request for Proposals was issued for the remedial action project management contractor and a radiological characterization report for the Weldon Spring Quarry was completed. In 1986, field work for characterization (radiological, chemical and geological) of the Chemical Plant area will be initiated and will continue into FY 1987. Preparation of a draft EIS to be issued in 1986 is underway. The Department's preferred alternative is stabilization of the wastes on site in a disposal cell designed to meet EPA requirements for the stabilization of uranium mill tailings. The project management contractor has been selected and a DOE onsite project office will be established in FY 1986. Conceptual design engineering by the project management contractor will begin in FY 1986 and continue through 1987. The Final EIS and Record of Decision will be issued in FY 1987. Contractors will be mobilized on the site, using local area labor, and remedial action will be started in FY 1987. We estimate that remedial

actions at the Weldon Spring site will be completed in FY 1995 and a final report issued by the end of FY 1996.

As previously mentioned, a new project will be added to the SFMP in FY 1987, decommissioning of the Power Burst Facility in Idaho. Current plans are to place the facility into an interim safe storage condition by initiating stabilization and fuel removal to dry storage in FY 1987. The facility is expected to be in a safe storage condition by the fourth quarter of FY 1988 or the first quarter of FY 1989. This condition will minimize surveillance and maintenance costs until funds are available for complete decommissioning, about 1993.

Other activities in FY 1987 will include continuation of site and facility disposition projects at Monticello, Utah; Santa Susana, California; the Argonne National Laboratory (ANL) in Illinois; the Oak Ridge National Laboratory in Tennessee; the Idaho National Engineering Laboratory in Idaho; and the Los Alamos National Laboratory (LANL) in New Mexico. Decommissioning of the reactor at the Center for Energy and Environment Research (CEER) in Puerto Rico will begin in FY 1986. At Monticello, Utah, mill tailings will be removed from 12 residential properties, leaving only about 6 properties to be completed in FY 1988. The environmental assessment will be completed for the Monticello mill site in FY 1986 and work on the site will start in FY 1987. Decontamination of surplus facilities at the 350 Area of the ANL-East complex will be completed in FY 1986 and preliminary

activities started for the decommissioning of the Experimental Boiling Water Reactor.

WEST VALLEY DEMONSTRATION PROJECT

The objective of the West Valley Demonstration Project is to demonstrate the solidification process for disposal of high-level liquid nuclear wastes under the provisions of Public Law 96-368, the West Valley Demonstration Project Act. An integrated production-scale development and demonstration project for treating high-level liquid nuclear wastes is being carried out at the Western New York Nuclear Service Center, near West Valley.

Major activities being performed as part of this project include: (1) demonstration required to prepare existing facilities and equipment to accommodate the solidification project; (2) removal of wastes from underground storage tanks; (3) development, design, construction, and operation of systems and necessary supporting facilities for the solidification of the wastes; (4) acquisition of containers for the permanent disposal of the solidified waste; (5) temporary storage and transportation of the solidified waste to an appropriate Federal repository for permanent disposal; (6) decontamination and decommissioning of the waste tanks, facilities, hardware, and material used in carrying out the project; and (7) disposal of low-level and transuranic wastes produced from project activities.

As the result of a detailed review, the estimate of total project costs through the waste solidification stage, excluding final

decontamination and decommissioning of the facility, was reduced to $442.4 million in year of expenditure dollars. This is a decrease of approximately $30 million from the previous estimate.

Project activities in FY 1985 led to the accomplishment of the most challenging goal of the Project to date, the start of verification testing of major subsystems of the Vitrification System. Individual testing of subsystems was completed in FY 1985 allowing for the start of integrated testing of all major portions of the Vitrification System. Other accomplishments during this period included completion of cleanup of the first of several former reprocessing cells and initial testing of the overall system that will solidify low-level liquid wastes.

During FY 1986, the design of all systems necessary to convert the Component Test Stand into the final shielded Vitrification Facility will be well underway. Radioactive testing in a pilot-scale vitrification system using the West Valley formula for the high-level waste form will be conducted to support the development of operational procedures for the West Valley Vitrification Facility. The final design of the Supernatant Treatment System to pretreat and reduce the volume of the liquid high-level waste will be completed as well as the civil construction and procurement activities for this system. Installation of equipment for treating low-level liquid wastes before they are solidified in cement will be completed in FY 1986. Decontamination of needed shielded cells will be continued to meet project needs.

In FY 1987, testing of the Vitrification System will concentrate on validation of process control techniques. In parallel, structural aspects of the conversion of the Component Test Stand into the final Vitrification Facility will be completed. The Supernatant Treatment System will be installed and testing completed leading to the start of supernatant processing in mid-FY 1987. The supernate now stored in underground tanks represents nearly 90 percent of the volume and 50 percent of the radioactivity of the stored liquid waste. The separated radioactive material will be stored and later blended with the sludge from the storage tanks and glass formers prior to being fed into the melter in the Vitrification Facility. The Liquid Waste Treatment System will be completed early in the year and used to treat low-level liquid wastes resulting from operation of the Supernatant Treatment System. Decontamination of needed hot cells will continue.

LOW-LEVEL WASTE MANAGEMENT ACTIVITIES

The Low-Level Waste Program provides assistance to States and regions in developing capacities for the disposal of low-level radioactive waste, in accordance with Public Law 99-240, the Low-Level Radioactive Waste Policy Amendments Act of 1985, enacted on January 15, 1986. This legislation has assigned individual States the responsibility for the disposal of low-level wastes generated within their borders, with the exception of waste generated as a result of certain Federal activities and civilian low-level waste exceeding the limits established by the NRC for

Class C low-level waste. The formation of regional compacts to carry out this responsibility is encouraged by the Act. The goal of the Department's Low-Level Waste program is to assist States and regions in the development of an effective nationwide low-level waste management system. The Act has also assigned several new responsibilities to the Department in addition to providing assistance to States and compact regions.

During FY 1986, the Low-Level Waste Program will conduct the activities required in the Act and will focus primarily on meeting the generic technical needs of the States and compact regions as they work to select sites and develop new disposal facilities. Specifically, the Department plans to concentrate on assisting States and regions in evaluating alternative disposal technologies to those currently in practice at the currently operating sites in Washington, South Carolina, and Nevada. The program will support the continued correction of problems and stabilization efforts at disposal sites no longer in operation and will continue to provide an evaluation of innovative waste treatment methods to the private sector. DOE expects to finish development of the procedures that will be used to evaluate proposals for transfer of closed low-level waste sites to the Department under Section 151 of the Nuclear Waste Policy Act of 1982.

In FY 1987, the Low-Level Waste Program will continue to provide technical assistance to States and regions to support the selection and development of new low-level disposal facilities;

support the correction of problems and stabilization at existing disposal sites; and complete an assessment of advanced, innovative methods for the treatment and disposal of low-level waste. The report identifying options for the Congress on disposing of greater-than-Class C low-level wastes will be completed by January 1987.

WASTE TREATMENT

The goal of the Waste Treatment Program over the past 5 years has been to develop and transfer technologies for the treatment and immobilization of nuclear wastes in forms acceptable for transportation, storage, and disposal. Efforts have been focused on determining the long-term reliability and maintaining the ability of a prototypical high-level waste treatment system, on testing and selecting acceptable high-level waste forms for storage or disposal, and on transferring treatment technologies to specific Departmental waste management programs such as the West Valley Demonstration Project.

In FY 1986 we will complete the second year of our efforts to determine the operational reliability, safety, and process control flexibility of the ceramic melter system for solidification of high-level radioactive wastes and continue collaborative programs with the Federal Republic of Germany and Japan on testing of a radioactive vitrification system.

In FY 1987, radioactive testing of the high-level waste vitrification system at the Pacific Northwest Laboratory will be

stopped unless individual users have a need for and fund additional research and development work. Reports on R&D results obtained in FY 1986 will be completed.

BYPRODUCTS UTILIZATION

In the FY 1986 Energy and Water Development Appropriations Act (Public Law 99-141), Congress provided resources for a civilian byproducts utilization program with a primary emphasis on food irradiation. We have proceeded--in cooperation with States, other Federal agencies, and private sector organizations--to develop plans and designs for establishing agricultural commodity irradiators in States selected on the basis of their needs and proximity to major agricultural production and processing centers. In anticipation of possible widespread use of food processing with irradiation, this program also focuses on developing an adequate U.S. based supply of radiation sources. Funding from the private sector will be sought for completion of these projects in future years, including FY 1987.

This completes my statement. I would be pleased to respond to any questions you may have at this time.

U.S. Department of Energy
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BIOGRAPHY

JAMES W. VAUGHAN, JR.

Mr. James W. Vaughan, Jr. assumed the position of the Principal Deputy Assistant Secretary for Nuclear Energy, Office of Nuclear Energy, at the U. S. Department of Energy (DOE) in March 1984. In this position, he oversees the technical management and programmatic direction of all programs assigned to the Assistant Secretary for Nuclear Energy.

Prior to his appointment as Principal Deputy, Mr. Vaughan had served since 1979 as Deputy Director of the Naval Nuclear Propulsion Program, a joint Department of Energy and Department of Navy effort currently headed by Admiral K. E. McKee, Deputy Assistant Secretary for Naval Reactors and Director, Naval Nuclear Propulsion Program. In that position he was the senior civilian in the organization, responsible for multiple aspects of management direction for the research, design, development, construction, testing, operation, and maintenance of over 170 operating naval nuclear propulsion plants and eight DOE naval reactor prototype plants.

From 1963 to 1979, Mr. Vaughan held various technical management positions within the Naval Nuclear Propulsion Program involving radiological controls, fuel materials development and testing, reactor plant mechanical components, and the Light Water Breeder Reactor.

Mr. Vaughan received a B.S. degree in electrical engineering from Duke University in 1957. From 1957 to 1959 he attended graduate level programs in nuclear reactor engineering at George Washington University and the University of Maryland. From 1957 to 1963 he served in the U. S. Navy.

Mr. Vaughan is a charter member of the Senior Executive Service. He was the recipient of a Meritorious Senior Executive Presidential Rank Award in 1983, and a Distinguished Senior Executive Presidential Rank Award in 1983. He also received a Meritorious Service Award for service with the DOE in 1978.

Mr. Vaughan is a native of Durham, North Carolina, and has resided in northern Virginia since 1957. He is married to the former Frances Smith. They have two children: Sandy, who attends Duke University, and Keith, who attends West Potomac High School.

NOTE: Mr. Vaughan is currently also serving as Acting Assistant Secretary for Nuclear Energy in addition to his assignment as Principal Deputy Assistant Secretary for Nuclear Energy. This additional assignment was effective September 1, 1988.

January 1988

MONDAY, MARCH 18, 1996

NUCLEAR ENERGY

WITNESS

RICHARD C. RUSCONI, DIRECTOR, OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

Mr. PETRI. Mr. Rusconi, if you will come up to the table, we will proceed.

The Chair recognizes you and you may proceed as you wish.

OPENING STATEMENT—WASTE MANAGEMENT

Mr. RUSCONI. Thank you, Mr. Chairman and members of the subcommittee. I am pleased to appear before you today to present the fiscal year 1997 budget for the DOE Office of Civilian Radioactive Waste Management.

We have provided advanced copies of my testimony a rather lengthy statement to the subcommittee.

Today, I would like to substitute a corrected copy of that earlier version for the record, and I believe I have provided corrected copies to each of the members.

The corrected version includes a number of changes to ensure we have honored fully our obligations relative to the injunction of the U.S. District Court and to be sure that we are in full compliance.

Mr. PETRI. Keeps you legal?

Mr. RUSCONI. Yes, sir, as well as protected.

Mr. PETRI. If there is no objection, the corrected statement will be made a part of the record.

Mr. RUSCONI. Thank you, Mr. Chairman.

Our budget request is under two funding areas. The nuclear waste fund finances a large portion of the budget and derives its revenue from fees collected from owners and generators of spent nuclear fuel and high-level radioactive waste.

The second area derives its funding from the general fund, and is used to support research and development of a generic nature.

Since the Nuclear Waste Policy Act of 1982 requires the submission of a triennial budget under the nuclear waste fund, our detailed budget request and formal statement provides estimates for fiscal year 1999 and 1998 as well.

I don't intend to spend much time on that subject today unless you have specific questions. Rather, I would prefer to turn to our request for fiscal year 1997, which request under the Nuclear Waste Fund is $709.3 million compared to $689 million in fiscal year 1996.

This request is representative of the administration's commitment to fully implementing the NWPA and it is essential to our view because of the need to take care of commercially generated, as well as defense, nuclear waste, but more importantly, its importance to all Americans.

Our request under the civilian R&D program is $0.3 million compared to $18 million in fiscal year 1996, consistent with our assessment of the best application of limited funds for such generic research.

I would like to turn then Mr Chairman briefly to discussion of the efforts under each of these two activities

[illegible]

The request under the fund is associated to table 1 of the formal statement and briefly it is an increase from the fund appropriation this fund year 1997 request is for operations at the level of $141.3 million compared to 1996 appropriations of $[illegible] million.

This increase will provide for extensive site characterization activities to begin exploratory shaft design and construction and to conduct intensive engineering tests and analyses to support the waste package and repository designs for the Yucca site.

We request to begin fiscal [illegible] environmental assessments, activities and have recommend to the President [illegible] proceed this year of April, Nevada sites for site characterization.

As a part of this process, we are planning to meet with the Technical Academy of Sciences at the end of March to discuss their conclusions with respect to our application of the ranking guidelines up to arriving at the recommendation of three sites for characterization.

The major milestones related to the fund repository activity are provided on page 11 of my formal statement.

[illegible]

For the second repository effort, the bill directs DOE to conduct site investigations for a second repository although construction of a second repository is contingent upon future Congressional authorization.

The fund year 1997 request in the budget under for nuclear waste second repository is $[illegible] million compared to the fund year 1996 appropriation of $[illegible] million. That category is associated [illegible] activities that would be for the second repository but have somewhat been identified as potentially acceptable but not conducive for site characterization for the fund repository work. Therefore, fund repository work is applicable to the second.

These characterized but not chosen for the fund repository site, and also found to be unsuitable acceptable. Work will [illegible] are previously studied [illegible] fund repository activities would be considered for the second repository. It is the DOE request for which $[illegible] million is requested and is previously to fund [illegible] activities for on-site work already which is published in begin in fund year 1998 activities with exploration work.

We are currently [illegible] the model of conducting [illegible] to public hearings and public meetings in the north western southwestern and southeastern areas to receive comments on a draft site [illegible] Nevada which program, a preliminary assessment site for which we would like to begin preliminary [illegible] work. These are based [illegible] and one [illegible] for in Nevada, three in Washington one in [illegible], and in North [illegible] one in [illegible] and one in Wisconsin.

Mr. Brown, didn't make it. Was

Mr. RUSCHE. I was hopeful Mr. Watkins could be around so we could talk based on your discussions of last week. Perhaps he will come back.

MONITORED RETRIEVABLE STORAGE

I would like now to turn to the monitored retrievable storage consideration. I am rather limited in what I can say about the MRS, other than as required by section 141 of the Act, we have completed the proposal and are prepared to send it to Congress on the need for and feasibility of an MRS. We believe that an MRS is an important and appropriate component of the integral waste disposal system we think ought to be in place for this country.

The fiscal year 1987 budget requests $46 million compared to $3 million appropriated in 1986, and should we have Congressional authorization and appropriation to proceed, would be used primarily for site data collection and analysis, final design, regulatory compliance studies and state liaison activities.

We are abiding by a court injunction of February 7 of this year, and, therefore, we have not submitted the formal proposal to Congress.

However, our appropriation request based on earlier review documents—provided to the Congress and others before that injunction was issued and in anticipation of the formal proposal which we had anticipated providing on February 10—provided bases for that consideration.

We hope to have resolution of the legal issues sometime early this summer. We have been granted an expedited schedule by the Court of Appeals in an attempt to resolve this matter.

Therefore, I want to make it clear that what I say here and in the corrections I made to the statement, be sure that I have not conveyed to you an impression that we have made a formal proposal to the Congress for an MRS.

TRANSPORTATION AND SYSTEMS INTEGRATION

Let me turn to transportation and systems integrations in the system. In 1987, we request for transportation and systems integration $33.4 million compared to $21.3 million in 1986.

The major activities for 1987 include funding for the private sector to design, fabricate and test prototype casks for transport from reactor to either an MRS or directly to repository.

This transportation activity is a very important element in the program because it touches almost all states and it is important, we believe, that we proceed.

If I may speak to the staffing requests. The 1987 request under program management and technical support will provide for a sustained staffing level from this year to next year of 292 full-time equivalent positions at headquarters and in the project offices to fund management, site investigation, technology development and institutional liaison.

RECEIPTS

Finally, under the waste fund, I would note that we anticipate receipts from the fees from utilities and from Federal activities related to the waste fund as follows: In fiscal year 1986, we anticipate receiving $498 million; fiscal year 1987, $538 million; fiscal year 1988, $587 million; and fiscal year 1989, $625 million, based on fees derived from net power generation as is the case we are now developing plus interest earned on investments.

I would note also, Mr. Chairman, that each year we are obligated to provide to the Congress our assessment of the total life-cycle cost of this program and the adequacy of these fees. We expect to have this year's assessment and cost estimates to the Congress, hopefully, by the end of this month.

CIVILIAN RADIOACTIVE WASTES R&D

If I may come to a conclusion quickly by turning to the civilian radioactive waste R&D program, that is, the generic research, our R&D efforts are to encourage and expedite availability of licensed nuclear at-reactor storage technologies.

Under the R&D program and from the general fund, we are requesting $6.5 million this year compared to $16 million in fiscal year 1986. We are requesting no funds for R&D concerning alternative means of disposal described in Section 222 of the Act, but instead are concentrating on cooperative agreements with utilities to demonstrate, for example, rod consolidation and industry storage technologies.

For program direction, we are requesting only $200,000 and requesting only three full-time equivalent positions as compared to five in fiscal year 1986.

You will note in the details of the statement that the primary difference between the R&D program we propose for 1987 and for this year, 1986, is that we have elected to bring to an orderly conclusion our work on the sub-seabed program following our evaluation of the priority and the limited availability of funds and taking note of advice received not only from others, but particularly from this committee of last year.

With that, Mr. Chairman, I think that is an appropriate place to stop this brief overview and I would be prepared to address questions that you and other Members may have.

[The statement of Mr. Rusche appears at the end of this hearing.]

MONITORED RETRIEVABLE STORAGE

Mr. BEVILL. Going back to the monitored retrievable storage proposal you talked about, my question is, is the NRC being cooperative and properly focusing its attention on the important safety matters of the program, or is it just taking a broad-brush approach and just asking for an infinite amount of information without proper focus on it?

Mr. RUSCHE. Mr. Chairman, I believe the Commission has done an excellent job in this area, perhaps in comparison with some of the other areas that we have talked about.

We are starting early enough in the program working together that we are not confronted with inheritance of the past, at least to an extreme degree.

I have had the opportunity, just before we anticipated sending the formal proposal on MRS to Congress, to review with the Commissioners in a public meeting that proposal and have, as required by the law, had their formal comments.

They were quite constructive, and I think that both that work and the work we are doing on the repository suggests that, one, we have a very real challenge. We never have licensed anything like a repository or MRS although MRS is much more typical of things we have done.

We are trying to follow, and I think the Commission is trying to follow, the spirit of the Act and working cooperatively where we can without compromising the independence of that regulatory body.

I believe continued work together will lead to a satisfactory result. But I would appreciate your time and your attention to be sure that continues year after year.

Mr. BEVILL. The Chair recognizes Mr. Myers.

Mr. MYERS. Thank you very much, Mr. Chairman.

Welcome back, Mr. Rusche. I think you are one of the deans of witnesses around here. You have been here a great many years, almost as long as Hunter Spillan, but not quite.

Mr. BONER. Were you saying Mr. Spillan had been on the payroll for a long time or he has been working here for a long time?

Mr. MYERS. I carefully didn't use that four-letter word, Mr. Boner.

Mr. BONER. Okay.

URGENCY OF WASTE REPOSITORY

Mr. MYERS. I have to watch my language.

This subject of how to handle our waste has been with us a number of years. There was a sense of urgency a few years ago when a newly elected President first sent a message to Congress before the end of his first term, which was his last term also, saying that he was going to develop a plan for a repository for our waste and we are still sitting around waiting for it.

I have about come to the conclusion that it is not near as urgent as we thought it was, and it really isn't with no new reactors coming on line.

Just how acute is it? What is the security risk and safety risk in storing waste at the reactor sites all over the country?

Mr. RUSCHE. Mr. Myers, I think the Commission has issued statements on the short-term safety and I don't think there is any question about storing spent fuel in basins for the immediate future.

I think the question that confronts us all is, we do have reactors in 27 states; we have licensed, it will be 100 shortly, and others yet to come. In spite of the fact there are no new orders, there are reactors in the pipeline coming.

We do have in those reactors that now exist something of the order of 12,000 tons of spent fuel stored in the basins and we have about that much in equivalent matter in defense facilities.

You will recall the Congress when it adopted NWPA instructed us to see where we should have separate facilities. The President accepted our recommendations and concluded last spring we need not have separate facilities. Therefore, in the civilian facility we would have both defense high level as well as civilian waste.

I think we certainly do not face a crisis. But I believe Congress recognized the extreme difficulty of this program and set us on a course in many people's minds that is almost a crash program to try to put in place such a repository by 1998.

It is interesting when I talk to people around the country, people criticize us for attempting to proceed too fast because they think we——

Mr. MYERS. Too fast?

Mr. RUSCHE. Yes, sir. Because they think we have in some cases not been as sensitive as we should to interact with states and other affected groups.

The Congress issued a very prescriptive Act in the NWPA. We have attempted to follow it not only to the letter but to the spirit as well. We have taken longer than Congress thought may be required because of this need to deal with people.

I think that no responsible judgment of this generation could conclude that we ought to back away from the course we are on. We have, I have, the Secretary, the Administration have reiterated in writing to you, and otherwise, that we believe the 1998 date for operation of a repository and our beginning to receive spent fuel or high-level waste is an important date for this country, and we need it. There is urgency in my own mind.

Whether you think that is the case or not, I guess you and other Members of Congress will have to decide. But we have based our funding and the Administration's support for the funding request that we have offered here, as clearly consistent with the President's agenda and October 1981 statement that the nuclear waste issue must be dealt with and we must begin now and begin effectively.

Mr. MYERS. Certainly this committee, as in the past, and in discussions with you and by our record, will indicate we have shown our concern about doing something about the nuclear waste.

FOREIGN WASTE DISPOSAL PRACTICES

The fact is we will wait until 1998 which in itself indicates there seems to be no urgency. In relationship to other countries such as France, members of this committee have visited the French operation where they store it out in a cement block building out in the open.

How can you justify our worrying about storing it in salt domes or wherever we make the final decision on where to put it, when you consider how other countries handle their waste?

Mr. RUSCHE. With respect to Europe and other countries, let me note just briefly that no country so far as I know has reached the state of definition and conclusion as has the United States.

France, Sweden, Germany, Japan have all taken steps to store waste on an interim basis. But to the best of my knowledge, no

country has set in motion a program for permanent disposal as has the United States.

The United States made that choice by you, by the Congress, based on studies that had been done both in the United States and around the world that we have the technology, we have the competition, we have engineering ability and it is right for this generation to pay for it and, therefore, we must take steps to dispose of the material.

So I would say that in this one area, at least in this one area within the nuclear business, we have again surged to the forefront. We are the leaders in the world in this business now.

Mr. MYERS. Well, which isn't saying a whole lot. We are the leaders, but look how slow we are moving, contrary to——

Mr. RUSCHE. I would like to invite you, Mr. Myers, sometime when you have a spare moment, to join me in some of the areas in which we are moving at the most rapid pace you can imagine, and I think you might get a different impression about whether we are moving efficiently and rapidly.

INTERIM WASTE STORAGE

Mr. MYERS. I don't question your efficiency; it is the speed of your action or inaction that I am concerned about right now, and I begin to question.

I think the urgency is there. I am still of the same resolve but I—I don't know that we can wait until 1998. What happens to the waste in the reactor sites between now and then?

NRC has primary responsibility for monitoring that, right?

Mr. RUSCHE. Yes.

Mr. MYERS. Do you exercise any monitoring or supervision, whatever, over it?

Mr. RUSCHE. No. It is the responsibility of the utilities to retain fuel until 1998 at which time we are obligated by contract to begin receiving it.

POTENTIAL VALUE OF SPENT FUEL

Mr. MYERS. There is or could be a value in this spent fuel if we go to a valid system where we use the fast breeder reactors. I see little value of the spent fuel unless we go to the fast breeder.

Is there any other value to the fuel other than in the fast breeder where we use the plutonium for civilian use?

Mr. RUSCHE. The spent fuel, of course, contains not only plutonium but uranium that has been unburned. So there is residual energy value of considerable amount.

It just turns out that with the current prices and availability of uranium and enrichment services, it is cheaper to mine, extract and enrich uranium than it is to reprocess the material.

Mr. MYERS. At some time in the future, if we should go to the fast breeder like other countries are going, would the spent fuel not be worth more than it would cost to store today or deposit residue after we extract the uranium and plutonium?

Mr. RUSCHE. I think there are two questions there: What is the value of the residual material, and that is the plutonium and/or uranium. That is in my mind—Mr. Vaughan might want to comment—essentially an economic question.

Whenever you produce fission, whether it is in the material that is there now or in reprocessed material or not, you produce waste.

Extracting and recycling the material does not reduce the amount of waste. It just reduces the amount of original material that is the uranium that you have to start with. However we use that material in terms of waste, any time we produce a megawatt hour, we produce a quantity of waste and we have to dispose of it.

So, I think the cost of the waste matter is not related to whether or not you recycle. It is the value of the energy that you get from it in comparison with the other sources which are freshly mined material.

Mr. MYERS. Would you care to comment on that?

Mr. VAUGHAN. Well, there are a couple of factors that involve the long-term economics.

For example, in France—the furtherest ahead on breeder reactors—their projections are currently that at best they might achieve one-and-a-half times the cost of the light water reactor given current costs of mining uranium and enriching it.

Mr. MYERS. One-and-a-half times?

Mr. VAUGHAN. Yes. A lot has to happen to the economics to make breeders more competitive.

We see in Japan that they are going through the same thing we went through in this country and that is looking at the pace of deployment of their breeder demonstrations. They probably will stretch their schedule out very much like we did because of the relative economics of the situation.

I think we are seeing a similar trend that we encountered here several years ago. That doesn't say that some day the need for breeder reactors in a long-term healthy economy won't come, but I think it has been pushed further out than was envisioned.

Mr. MYERS. You mentioned—pardon me?

Mr. VAUGHAN. I was finished.

FRENCH REPROCESSING PLANT

Mr. MYERS. You mentioned France. Is France going on line with their reprocessing plant near Cherbourg?

Mr. VAUGHAN. Yes, and they have been operating for some time, processing both——

Mr. MYERS. "Operating," but do you mean in full production?

Mr. RUSCHE. To the best of my knowledge, yes.

Mr. MYERS. For commercial use.

Mr. RUSCHE. Not only for its own use but services for foreign countries as well.

Could I make a comment that bears on this subject?

Mr. MYERS. Sure, you have the floor.

POTENTIAL VALUE OF SPENT FUEL

Mr. RUSCHE. The potential future value of spent fuel which we now visualize as being disposed of in an MRS or repository, however, is a matter that has not escaped the attention of the program. Under the Congressional mandate, it is not the function of this program to either promote or retard the use of such reprocessing or

other attempts to extract more energy from that given amount of fuel.

On the other hand, we did and have incorporated both in our regulations and in the regulations of the NRC a provision that requires that the material placed in the repository must remain retrievable or recoverable for at least 50 years, primarily for the purpose of determining that its engineering performance is what we thought.

It also provides accessibility should the circumstances that we envision now for the next 10 or 15 years be replaced by a system or circumstances that indicate 50 years from now we will not have abandoned the material in such a permanent way that it would be very difficult to go back and get it.

I think that is the factor that oftentimes is lost and it is the provision that Congress made. It is just not borne out of the ingenuity of myself or others who looked at it.

Congress recognized that material has value, but particularly it is important to assure to the best of our ability that safety provisions have been adequately taken care of. But it also provides other assurances.

INCREASED WASTE

Mr. MYERS. Earlier Mr. Vaughan testified before the committee that we had contracted or would be contracting for increased usage of our SWUs from, I think, 46 to 53 percent by 1991. That will increase also the demand for reprocessing it and for the waste? Are we still responsible for handling the waste? Is that built into the 1998 figures?

You gave encouraging hopes anyway for after 1991 or even for further increased use of American production of fuel. What demand will that put on the future storage and handling and disposal of our waste?

Mr. RUSCHE. There are two questions.

Mr. MYERS. I sure get involved. I wish I could do that well when I play the daily double.

Mr. RUSCHE. Your insight is what I thought it was.

Enrichment utilization and its effectiveness is a separable question from how much waste there is.

Mr. MYERS. Sure.

Mr. RUSCHE. The waste depends on how much power you produce. Wherever you get the material to produce it from, whether from new enrichment or recycling through reprocessing or another type reactor or even a natural uranium reactor, they are just expensive. When you produce power, you produce waste.

The obligation we have under the Act is to accept all such waste in whatever form for permanent disposal for defense and civilian purposes.

Mr. MYERS. Well, if the utility companies and those who predict that the economy and demand for electric energy are accurate, by about eight or nine years from now, we will have a significant increase in demand for electric power.

Mr. RUSCHE. Yes.

Mr. MYERS. And today at least no prospects of the generation will be there. It will have to come from somewhere, conventional which involves acid rain like the discussion we have every day, not every day but frequently, may play a role and preclude us from using more fossil fuel, coal.

Even though the oil price is reduced there is a limitation on that. You can't build another dam for hydro.

Where will it come from if it doesn't come from nuclear? We had the earlier discussion about reactors. Are we going to in 1998 when you come on line with this reprocessing, will we have such a tremendous backlog that we will have to build four or five real quick?

Mr. RUSCHE. Reprocessing? With the waste system?

Mr. MYERS. To dispose of the waste, yes.

Mr. RUSCHE. No.

Mr. MYERS. Whether it be vitrification or whatever you decide.

BACKLOG OF SPENT FUEL

Mr. RUSCHE. We have decided, or are obligated, to design a facility that has sufficient capacity and flexibility to accept whatever waste is produced whenever it is produced. We believe that will be the case.

Now, you recall that you and Congress did provide in the Act that we may not put more than 70,000 tons in the first repository until we have a chance to come back and talk to you and you will decide we should authorize a second repository or remove the 70,000-ton limitation.

Mr. MYERS. We have 12,000 tons right now.

Mr. RUSCHE. I think that is about right, 12- or 14-. The total amount of waste we envision from all reactors now on order or in the process of being constructed is of the order of 120- to 140,000 tons.

Mr. MYERS. So you will be right up there pushing it, the 70,000.

Mr. RUSCHE. The 70,000?

Mr. MYERS. You will be over it by the time we get there, won't you?

Mr. RUSCHE. No, we expect to have less than 70,000 tons by the time we get to 1998.

Mr. MYERS. Okay.

Mr. RUSCHE. The total then may be on the order of 45- or 50,000 tons or something of that order.

Mr. MYERS. But if this has the potential realized, we will capture more of the world market, then you will be pushed back again—you keep shaking your head.

ENRICHMENT SERVICES

Mr. VAUGHAN. Let me separate that subject from Mr. Rusche's subject.

What those numbers refer to in terms of the enrichment services is the percentage of the market that the U.S. uranium enrichment enterprise operated by DOE is planning to sell to customers.

If there are 120 operating reactors in the country by the year 1995, they are going to have to buy enrichment services from somewhere in order to produce the fuel. They are going to produce the same amount of fuel to operate those reactors whether they buy enrichment services from DOE, or from our foreign competitors. So the total amount of waste that they will generate is really not relevant to who they buy their enrichment services from.

Mr. MYERS. One of my questions is, that the 400,000 SWU generated, is it for foreign or domestic use?

Mr. VAUGHAN. Both. What it reflects is simply the more aggressive marketing techniques and the continuing decline of enrichment prices that we project.

So what the number you referred to reflects is with our marketing approach, we believe we have captured back more of the market than had eroded and kept it from our foreign competitors.

Mr. MYERS. Won't that generate more waste?

Mr. VAUGHAN. Not necessarily, because if the utilities didn't buy enrichment services from us, then they would buy from our competitors.

Mr. MYERS. But we have to handle the waste?

Mr. VAUGHAN. Yes.

Mr. MYERS. If it is generated in this country, used in this country, we have to be responsible for the waste.

Mr. VAUGHAN. Yes.

Mr. RUSCHE. That is correct.

Mr. MYERS. If the growth is there, if it expands more than you anticipate and you get more of the foreign market—we still take care of the foreign waste, do we not?

Mr. RUSCHE. That is a confusion I didn't make clear. We have the opposite situation. We do not have the obligation to take foreign waste in this program.

Mr. MYERS. Define "foreign" waste.

Mr. RUSCHE. Waste generated in a foreign country.

Mr. MYERS. I thought under the nuclear agreement—what is it?

Mr. VAUGHAN. Nonproliferation treaty.

Mr. MYERS. Nonproliferation. I thought all the waste came back to us for reprocessing. I thought we had to take it all back.

Mr. RUSCHE. Only for a few limited research and development activities, sir.

Mr. MYERS. That is where I misunderstood it.

Mr. RUSCHE. I apologize, because I——

Mr. VAUGHAN. I apologize too, because I didn't sense the nature of the question.

Mr. MYERS. I thought that if we captured all the foreign market and we would load up our waste disposal system.

Mr. RUSCHE. No, we are not.

Mr. VAUGHAN. No, we are not obligated to take that back. The nuclear nonproliferation agreement does provide some bilateral agreement between countries that they will not use the fuel or the waste products from fuel to make weapons.

Mr. MYERS. I have several other questions and I apologize to my colleagues here.

MONITORED RETRIEVABLE STORAGE

Under the sequence, would it seem reasonable that we would build a monitored retrievable storage before we build the permanent repository?

Mr. RUSCHE. Yes, sir.

Mr. MYERS. That is what you plan?

Mr. RUSCHE. That is what we believe would be appropriate.

Mr. MYERS. But yet they are still moving on about the same parallel, same speed?

Mr. RUSCHE. No, sir. If we were able to bring the proposal to Congress or if Congress, chose on its own initiative based on the information available, to authorize us to proceed with MRS, we would have the MRS in operation at least two years before the repository could be in operation on the most optimistic schedule we had chosen and perhaps sooner than that.

We believe that it has considerable potential for improving the repository program by allowing us to deal with a number of factors, factors related to transportation, with respect to regulation, and it is for those reasons that we believe MRS ought to be initiated. We ought to proceed as fast as we can practically do it.

Mr. MYERS. Then spent fuel would go to the MRS and spend a period of time there before it went into the permanent repository, before reprocessing?

Mr. RUSCHE. Certainly before the repository and the time would depend on logistics, but primarily it would pass through MRS for packaging in preparing for final disposal.

We would propose, if we ever get the proposal to Congress, as we indicated in the draft documents, a storage capacity of about 15,000 tons at the MRS.

Mr. MYERS. I am sure we will hear more about the MRS so I will not get into that field.

I have other questions, but I will submit them for your response for the record.

Mr. RUSCHE. I appreciate the opportunity, sir.

Mr. BEVILL. The Chair recognizes Mr. Boner.

Mr. BONER. Thank you, Mr. Chairman.

I don't have that many questions. I would like to take this opportunity to state my position, and before I do that, I would be remiss if I didn't recognize and express my appreciation to Ben Rusche for his cooperation and strong sense of purpose.

We had a public hearing in Nashville, Tennessee, and he was able to field many questions in many unusual circumstances, and did an outstanding job of doing that. I guess dealing with nuclear waste has to be one of the toughest jobs at DOE, and Ben Rusche has managed it with skill and dedication, and I certainly appreciate that.

But I also feel that I must take this opportunity to explain my position on the Department of Energy's proposal for the MRS even though it is not before the Congress.

From the beginning my position has been that the burden would be on the Department of Energy to convince first the people of Tennessee and second the members of Congress for the need for an

MRS. I have attempted to gather facts and study the proposal in all of its parts.

In January, Mr. Chairman, I held a public meeting in Nashville focusing on this issue. At that hearing, I said that I would listen carefully to the comments and questions of the people I represent and I have done that. I said that the people of Tennessee would ask tough questions, and they would demand straight answers, and they have.

I said that in the end, their judgment would be fair, and I believe it has been. I said my position, my vote would be based on that judgment, and it is.

That is why I strongly oppose placing an MRS facility in Tennessee and must respectfully submit placing it anywhere in the United States.

When Congress passed the Nuclear Waste Act of 1982 it did so out of recognition of the need to address the serious and growing problem in nuclear waste disposal. That Act mandated the building and operation of a permanent site by 1998, and was evidence of a broad consensus on the need for and feasibility of such repository.

The Act did not mandate an MRS and in fact we in Congress clearly expressed our doubts about the MRS in a committee report, noting that there were not conclusive technical, economic or social reasons for developing MRS at this time.

We asked the DOE to submit a study on the need for and feasibility of an MRS. That study was submitted in April last year at the same time that DOE also announced that there were three potential sites, all in Tennessee, that had been selected for an MRS.

Many of us saw the report as nothing more than a thin justification for a decision DOE had already made in the face of its continuing problems developing a permanent repository.

Many questions have been raised regarding the feasibility of MRS especially focusing on safety. These relate to problems with transportation, handling and actual storage itself, including in this age of terrorism, the security for the site.

I do not believe these questions have been answered adequately. But feasibility, as a consideration, is second to need.

Virtually every Administration witness who has appeared before this panel, or anywhere else, has used the excuse of budgetary restraints or Gramm-Rudman to justify drastic cuts in and sometimes elimination of programs.

Those that remain are dependent on the basis of absolute necessity. By the Administration's own logic, the question becomes: Is this program absolutely necessary? That is, where would the ultimate goal of a permanent repository fall in the absence of an MRS?

Not by any stretch of the imagination, when I had a chance to talk to many of the witnesses from the Department of Energy, it was not determined that the MRS was an absolute necessity prior to the permanent repository site. Experts in government and industry argued that an MRS would be nice to have, it would be beneficial, but I don't believe it has been suggested that it is absolutely necessary. Even the statutorily required study on the need for an MRS discussed the reasons that at best could only be described as desirable.

One of the principal justifications mentioned by DOE is its opportunity to demonstrate to states and utilities its ability and good-faith willingness to work closely with the affected parties on problems and solutions. But realities suggest otherwise, and at this moment DOE has been enjoined by Federal District Court from submitting its proposal to Congress precisely because in the opinion of those representing the Tennessee government, it did not carry out its statutory duty to consult and cooperate with the state. Thus, DOE will not be able to submit its proposal until at least six more months up to a year.

Last Monday in this room I asked Secretary Herrington what effect the Court's decision would have on his request for $46 million in appropriations for MRS, and his response was in short, "None."

I can only assume that that response indicates that he would plan to go forward with the proposal, but I have to assume that it must be with the consent of Congress, both from the appropriations side and the authorization side.

Accordingly, Mr. Chairman, I will have to fight any and all funds earmarked from MRS to be removed from this appropriations bill, and I feel that in representing the colleagues of Tennessee and the constituents, not only from throughout the entire state but especially from the Fifth District, that we have an obligation to go forward with locating the permanent repository on time and without distractions, and hopefully we can do so by eliminating an MRS facility, especially, being located in Tennessee.

Mr. Chairman, I have no questions. I think that in the times that I have been able to visit with Ben Rusche he has done an excellent job of communicating to me and to many of the people that have asked questions about an MRS facility. I think he articulates the need for and the reasons for an MRS facility, I think that he certainly is to be commended for his work throughout the entire area of where are we going to put our nuclear waste facilities.

I am hopeful, Mr. Chairman, that as we evaluate the hard work that Ben Rusche and others have done, that we will be able to insure that a permanent repository can be located, and that we will be able to avoid the cost of an MRS facility, and expedite the establishment of a permanent repository.

Thank you, Mr. Chairman.

Mr. BEVILL. Very good. Mr. Rusche, we have several more questions here we are going to submit for the record.

SECOND REPOSITORY

Mr. MYERS. I have a number for the record. On page 13 of your prepared text you talk about the second repository, and on page 14 you have the milestones. It seems difficult for me to understand why you need so much money for each of these milestones with much of it probably already done. It would appear that in your first repository you have done a lot of this work, so couldn't you justify it for the record, further amplify why you need this much money in 1987, 1988, and 1989?

Mr. RUSCHE. I would be delighted to indicate that for the record.

Mr. MYERS. Or discuss now, if you would prefer.

Mr. RUSCHE. The record is all right.

Mr. MYERS. The record is all right.

Mr. RUSCHE. Fine, I will be delighted. It is very difficult work, in every place different.

Mr. MYERS. Thank you.

Mr. BEVILL. The committee stands adjourned until 10 o'clock in the morning.

[The following questions and answers were provided for inclusion in the record:]

NUCLEAR WASTE DISPOSAL FUND

Mr. Bevill. What is the current status of the permanent repository program? What problems have occurred or conditions have changed in the past year?

Mr. Rusche. The Nuclear Waste Policy Act established the process to be followed for the permanent geologic repository program. The principal elements of the site selection process are to identify potentially acceptable sites, issue guidelines for selecting sites, publish environmental assessments to accompany the nomination of candidate sites for detailed characterization, select sites for characterization and conduct the characterization program, and select the final repository site.

In the first repository program, potentially acceptable sites were identified in 1983 and the Siting Guidelines were published in the Federal Register in December 1984. Draft environmental assessments were also published in December 1984. Although the NWPA did not require publication of the environmental assessments in draft, this step was in keeping with the spirit of consultation and cooperation called for in the NWPA. It is the Office of Civilian Radioactive Waste Management's (OCRWM) belief that by publishing the draft environmental assessments for review and comment, it will, in the long-run expedite rather than delay completion of the site selection process.

Following issuance of the draft environmental assessments, public hearings were held in each of the affected States to receive comments from local citizens. Approximately 20,000 written comments were received. During the remainder of 1985, these comments were organized by subject, analyzed and either accepted as improvements to the environmental assessments, or a response was prepared explaining the reason for non-acceptance. The final environmental assessments were in preparation at the end of September.

In conjunction with preparation of the final environmental assessments, OCRWM made a request to the National Academy of Sciences' (NAS) Board on Radioactive Waste Management for an independent review of the ranking methodology used to evaluate sites for recommendation for characterization. The NAS Board found the methodology suitable if appropriately applied and recommended a further independent review after application of the methodology. Therefore, plans were made with the NAS Board for further coordination and review during early 1986. Publication of the final environmental assessments is scheduled for April 1986. Following Presidential approval of the sites to be characterized, detailed site characterization will begin.

In the second repository program, a draft Area Recommendation Report was issued in January 1986 that proposed sites in crystalline rock bodies for further investigation. Following receipt and evaluation of comments on the draft, a final report will be issued that will identify the crystalline rock bodies to be investigated. Because of the time required to complete the area-phase investigations, including evaluation of data and preparation of the required environmental assessments for the second repository program, and the need to maintain proper phasing between the first and second repository programs, the date for the President to recommend three candidate sites for characterization has been rescheduled to December 1993.

Mr. Bevill: When do you expect to start drilling the exploratory shafts at each site selected for site characterization?

Mr. Rusche: The current plan is to start exploratory shaft construction in basalt and tuff in May 1987, if candidate sites in those geologic media are selected. The current plan is to start exploratory shaft construction in salt in April 1988.

FUNDS APPROPRIATED FOR CONSTRUCTION OF EXPLORATORY SHAFTS

Mr. Bevill. Since the activity has been delayed, have you retained all the monies appropriated in the FY 1986 budget for that effort or have those funds been spent on some other activities?

Mr. Rusche. Funds appropriated for construction of the exploratory shafts have not been utilized for other purposes. However, as a result of this delay, approximately $9.0 million of budget authority related to exploratory shaft activities was made available for sequestration as part of the Gramm-Rudman-Hollings deficit reduction act.

FY 1986 CHARACTERIZATION FUNDS

Mr. Bevill. Please explain if portions of FY 1986 characterization funds have been reprogrammed and for what purpose?

Mr. Rusche. No portion of FY 1986 Site Characterization funds have been reprogrammed to other areas.

Mr. Bevill. If so, how have these expenditures helped you satisfy the schedule called for in the NWPA?

Mr. Rusche. As indicated in the previous answer, no funds have been reprogrammed.

NUCLEAR WASTE DISPOSAL FUND

FY 1987 BUDGET REQUEST

Mr. Bevill. What criteria do you use for determining whether a proposed research task is needed for the program and when the task should be done?

Mr. Rusche. The research and development tasks required to support the program are primarily in the nature of development, test and evaluation activities. Within that context, several sets of criteria may apply, depending upon the current state of the technology and the maturity of the program. In the former instance, program or specific project requirements are initially determined using a systems engineering and integration discipline which defines the total system and interfaces required to meet the specific objectives of the missions. The functions required and the methods for accomplishing them are evaluated within the current state of the technology for availability, adequacy, reliability and cost. Deficiencies will prompt the initiation of activities designed to resolve the issues involved. As the program or project matures the criteria set may change and/or expand due to several factors such as, changes in technology, institutional issues or technology requirements. The criteria may then include additional factors such as reduced program risk,

environment, health and safety considerations and enhanced confidence in the ability of the system to perform in the manner intended and within the time frame required. Proposed activities which meet these criteria will be initiated. Since the process is continually examined and evaluated with the purpose of meeting the mission need, the criteria set used for any specific proposed activities may include some or all of the aforementioned items.

NUCLEAR WASTE DISPOSAL FUND

FY 1987 BUDGET REQUEST

Mr. Bevill. How are research needs being determined; what influence does NRC staff have over this process?

Mr. Rusche. The determination of research needs has been described in the response to the preceding question. With respect to influence of the NRC staff over this process, the DOE has established and maintains an effective interface with the Nuclear Regulatory Commission's Office of Nuclear Materials Safeguards and Security and their Office of Nuclear Regulatory Research. The DOE and NRC staffs meet frequently to exchange information on the status of development, test and evaluation projects and the plans for acquiring sufficient technical basis for program needs related to their licensing and rule making process. In some projects such as spent fuel development, DOE and NRC staffs participate along with EPRI and the utilities to coordinate plans and activities involved in establishing or expanding the technology bases for the projects.

EFFECT OF APPROVAL THIS YEAR TO PROCEED WITH THE MRS

Mr. Bevill. Will Congressional approval this year to proceed with the MRS permit you to meet the promised schedule to take responsibility for the spent fuel from utilities by 1998 as required in the NWPA and in your contracts with the utilities?

Mr. Rusche. Integration of an MRS into the waste disposal system would greatly increase system flexibility and, therefore, enhance the program's ability to optimize operation of the system. It is anticipated that early authorization of an MRS would permit acceptance of waste beginning in 1996.

LIKELIHOOD OF MEETING COMMITMENTS WITHOUT AN MRS

Mr. Bevill. What level of probability do you assign to meeting these commitments without an MRS?

Mr. Rusche. As previously indicated, integration of an MRS into the waste disposal system would enhance the program's ability to begin accepting waste at an earlier date. However, whether or not an MRS is approved, the program is committed to begin accepting waste by 1998. It is difficult, at this early stage of the program, to determine, with confidence, the probability of meeting the 1998 date. We believe that it is achievable, but will be carefully assessing our schedule about this time next year when we hope to have a better definition of the waste management system (viz., after geologic repository sites are identified for characterization and we have more certain knowledge of whether an MRS will be part of the system).

NUCLEAR WASTE DISPOSAL FUND

FY 1987 BUDGET REQUEST

Mr. Bevill. What can the Congress do to assist in achieving the desired "consultation and cooperation" with the potential host states for the repository and MRS?

Mr. Rusche. The consultation and cooperation (C&C) process to date has shown it to be a very demanding process on the part of these involved states, Indian Tribes, and the Department of Energy. In the repository program, until recently the Department has been negotiating a C&C agreement with the Umatilla Indian Reservation. At this time there is no clear indication when the agreement will be signed, though recent information is that formal negotiating sessions will begin again. Concerning the MRS proposal, the State of Tennessee has filed a law suit against the Department because the State believes that the Department failed to enter into a C&C process concerning MRS siting within the State. The Department firmly disagrees with the states position. Initial rulings on the law suit have prevented the Department from formally submitting its proposal to the Congress on the MRS facility, as required by the NWPA.

In regard to what Congress can do to assist in achieving a desired C&C with potential host states for an MRS or a

repository, the Department has identified several major areas in the MRS proposal that would significantly strengthen overall institutional relations with potential host states and local communities. The recommendations we make for institutional provisions would be beneficial for the overall nuclear waste program. Recognizing the court injuction, however, we are unable to discuss our specific recommendations at this time since they do relate to a recommended site for the MRS. The Department is enjoined from communicating with the Congress on any siting aspects of the MRS proposal.

Mr. Bevill. Does the Congress need to do something to assure that you have available to you the best legal support to handle the many legal and licensing challenges that have been thrown at the waste program?

Mr. Rusche. The Department considers that no Congressional action is needed at the present time to provide additional legal support to the waste management program. The Office of General Counsel in the Department is providing appropriate and sufficient support to the Office of Civilian Radioactive Waste Management.

Mr. Bevill. Is there any pending litigation that could delay implementation of the program? If so, discuss it and the potential delay.

Mr. Rusche. There are two cases now pending that have the potential to delay implementation of the program. In the case of the Environmental Policy Institute and others versus the Department concerning DOE's actions in promulgating the siting guidelines, an adverse ruling could delay the selection of first repository sites for site characterization. And in the case of the State of Tennessee versus the Department concerning the study of possible locations for the Monitored Retrievable Storage facility, DOE has been enjoined from making any proposal to Congress. As I indicated in my formal statement, we have appealed to the Sixth Circuit Court the decision of the Federal District Court of the Middle District of Tennessee, and we are hopeful that we will receive a speedy resolution.

ANNUAL ESTIMATED COST OF THE PROGRAM

Mr. Bevill. What is the annual estimated cost of this program for each fiscal year through project completion?

Mr. Rusche. Annually, the total system life cycle costs of the program are estimated for a number of different media pairs for the first and second repositories. Attached are the current estimated annual costs for the high-cost media pair, the low-cost media pair and the median-cost media pair.

Table C-1
Annual Total System Costs
Reference Case - Authorized System (Basalt/Crystalline High)*
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
1983	226	0	0	0	226
1984	284	0	0	0	284
1985	305	0	0	0	305
1986	493	0	0	0	493
1987	643	0	0	0	643
1988	721	0	0	0	721
1989	631	0	0	0	631
1990	578	41	0	0	619
1991	328	72	0	0	400
1992	242	46	0	0	288
1993	286	205	0	0	491
1994	408	437	0	0	846
1995	418	429	0	0	847
1996	417	400	0	0	817
1997	392	287	0	0	679
1998	308	237	0	28	572
1999	249	156	37	7	450
2000	150	100	65	8	323
2001	106	116	41	34	296
2002	93	184	72	73	422
2003	130	306	335	110	881
2004	115	306	462	76	959
2005	115	306	399	70	890
2006	114	306	296	69	786
2007	114	306	251	68	739
2008	102	306	181	63	652
2009	25	306	154	89	574
2010	25	306	154	64	548
2011	25	306	154	63	547
2012	25	306	154	72	557
2013	25	275	193	63	556
2014	25	275	258	88	646
2015	25	275	258	71	629
2016	25	275	258	95	653
2017	25	275	258	88	647
2018	25	275	258	133	691
2019	25	275	258	119	677
2020	25	275	258	93	651
2021	25	275	258	78	636
2022	25	275	258	84	642
2023	25	207	258	58	547
2024	25	29	232	28	313
2025	25	29	232	36	321
2026	25	29	232	30	315
2027	25	29	232	31	316

*Two different crystalline cases are analyzed for a second repository. The Crystalline High Case assumes a harder rock structure and at greater depth than does the Crystalline Low Case.

Table C-1 (continued)
Annual Total System Costs
Reference Case - Authorized System (Basalt/Crystalline High)
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
2028	25	29	232	31	316
2029	25	29	232	30	316
2030	25	29	176	21	251
2031	15	29	27	0	70
2032	15	29	27	0	70
2033	15	29	27	0	70
2034	15	29	27	0	70
2035	15	29	27	0	70
2036	15	29	27	0	70
2037	15	29	27	0	70
2038	15	29	27	0	70
2039	15	29	27	0	70
2040	15	29	27	0	70
2041	15	29	27	0	70
2042	15	29	27	0	70
2043	15	29	27	0	70
2044	15	29	27	0	70
2045	15	29	27	0	70
2046	15	29	27	0	70
2047	15	29	27	0	70
2048	15	49	27	0	90
2049	15	49	27	0	90
2050	15	49	27	0	90
2051	15	49	27	0	90
2052	15	49	27	0	90
2053	15	49	27	0	90
2054	15	49	27	0	90
2055	15	49	27	0	90
2056	15	49	27	0	90
2057	15	49	27	0	90
2058	15	49	53	0	117
2059	15	49	53	0	117
2060	15	49	53	0	117
2061	15	49	53	0	117
2062	15	49	53	0	117
2063	15	49	53	0	117
2064	15	49	53	0	117
2065	15	49	53	0	117
2066	15	49	53	0	117
2067	15	49	53	0	117
2068	15	49	53	0	117
2069	15	49	53	0	117
2070	15	49	53	0	117
2071	15	49	53	0	117
2072	15	49	53	0	117

Table C-1 (continued)
Annual Total System Costs
Reference Case - Authorized System (Basalt/Crystalline High)
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
2073	15	49	53	0	117
2074	15	49	53	0	117
2075	15	49	53	0	117
2076	15	49	53	0	117
2077	15	49	53	0	117
2078	15	49	53	0	117
2079	15	49	53	0	117
2080	15	49	53	0	117
2081	15	49	53	0	117
2082	15	27	53	0	95
2083	15	40	53	0	108
2084	15	67	53	0	135
2085	15	80	24	0	119
2086	15	53	35	0	104
2087	15	0	59	0	74
2088	15	0	71	0	86
2089	15	0	47	0	62
TOTALS	9403	11339	9478	2070	32289

Table C-5
Annual Total System Costs
Reference Case – Authorized System (Salt/Crystalline High) *
(Millions of 1985 Dollars)

YEAR	O & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
1983	226	0	0	0	226
1984	284	0	0	0	284
1985	305	0	0	0	305
1986	493	0	0	0	493
1987	643	0	0	0	643
1988	721	0	0	0	721
1989	631	0	0	0	631
1990	578	38	0	0	616
1991	328	66	0	0	394
1992	242	42	0	0	284
1993	286	189	0	0	475
1994	408	404	0	0	812
1995	418	396	0	0	814
1996	417	370	0	0	787
1997	392	265	0	0	657
1998	308	213	0	23	544
1999	249	139	37	5	430
2000	150	86	65	5	307
2001	106	94	41	23	264
2002	93	144	72	53	362
2003	130	234	335	105	804
2004	115	234	462	63	873
2005	115	234	399	45	792
2006	114	234	296	42	686
2007	114	234	251	47	646
2008	102	234	181	55	572
2009	25	234	154	63	476
2010	25	234	154	56	468
2011	25	234	154	51	464
2012	25	234	154	53	466
2013	25	211	193	64	493
2014	25	211	258	80	575
2015	25	211	258	66	560
2016	25	211	258	72	566
2017	25	211	258	87	581
2018	25	211	258	107	601
2019	25	211	258	105	599
2020	25	211	258	63	558
2021	25	211	258	65	559
2022	25	211	258	57	551
2023	25	161	258	51	495
2024	25	22	232	28	306
2025	25	22	232	33	312
2026	25	22	232	28	307
2027	25	22	232	29	308

*Two different crystalline cases are analyzed for a second repository. The Crystalline High Case assumes a harder rock structure and at greater depth than does the Crystalline Low Case.

Table C-5 (continued)
Annual Total System Costs
Reference Case - Authorized System (Salt/Crystalline High)
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
2028	25	22	232	29	307
2029	25	22	232	28	307
2030	25	22	176	19	242
2031	15	22	27	0	63
2032	15	22	27	0	63
2033	15	22	27	0	63
2034	15	22	27	0	63
2035	15	22	27	0	63
2036	15	22	27	0	63
2037	15	22	27	0	63
2038	15	22	27	0	63
2039	15	22	27	0	63
2040	15	22	27	0	63
2041	15	22	27	0	63
2042	15	22	27	0	63
2043	15	22	27	0	63
2044	15	22	27	0	63
2045	15	22	27	0	63
2046	15	22	27	0	63
2047	15	22	27	0	63
2048	15	39	27	0	81
2049	15	39	27	0	81
2050	15	39	27	0	81
2051	15	24	27	0	66
2052	15	37	27	0	78
2053	15	61	27	0	103
2054	15	73	27	0	115
2055	15	49	27	0	91
2056	15	0	27	0	42
2057	15	0	27	0	42
2058	15	0	53	0	68
2059	15	0	53	0	68
2060	15	0	53	0	68
2061	15	0	53	0	68
2062	15	0	53	0	68
2063	15	0	53	0	68
2064	15	0	53	0	68
2065	15	0	53	0	68
2066	15	0	53	0	68
2067	15	0	53	0	68
2068	15	0	53	0	68
2069	15	0	53	0	68
2070	15	0	53	0	68
2071	15	0	53	0	68
2072	15	0	53	0	68

Table C-5 (continued)
Annual Total System Costs
Reference Case - Authorized System (Salt/Crystalline High)
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
2073	15	0	53	0	68
2074	15	0	53	0	68
2075	15	0	53	0	68
2076	15	0	53	0	68
2077	15	0	53	0	68
2078	15	0	53	0	68
2079	15	0	53	0	68
2080	15	0	53	0	68
2081	15	0	53	0	68
2082	15	0	53	0	68
2083	15	0	53	0	68
2084	15	0	53	0	68
2085	15	0	24	0	39
2086	15	0	35	0	50
2087	15	0	59	0	74
2088	15	0	71	0	86
2089	15	0	47	0	62
TOTALS	9403	7946	9478	1699	28525

Table C-10
Annual Total System Costs
Reference Case - Authorized System (Tuff/Crystalline Low) *
(Millions of 1985 Dollars)

YEAR	O & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
1983	226	0	0	0	226
1984	284	0	0	0	284
1985	305	0	0	0	305
1986	493	0	0	0	493
1987	643	0	0	0	643
1988	721	0	0	0	721
1989	631	0	0	0	631
1990	578	23	0	0	601
1991	328	40	0	0	368
1992	242	26	0	0	268
1993	286	115	0	0	401
1994	408	246	0	0	655
1995	418	242	0	0	660
1996	417	226	0	0	642
1997	392	162	0	0	553
1998	308	164	0	26	498
1999	249	118	27	7	402
2000	150	86	48	7	292
2001	106	94	30	34	265
2002	93	129	53	70	345
2003	130	193	248	125	695
2004	115	193	341	79	728
2005	115	193	295	64	666
2006	114	193	219	60	586
2007	114	193	186	59	552
2008	102	193	133	59	487
2009	25	193	107	70	395
2010	25	193	107	55	380
2011	25	193	107	54	379
2012	25	193	107	54	379
2013	25	177	132	62	397
2014	25	177	174	70	445
2015	25	177	174	58	434
2016	25	177	174	79	454
2017	25	177	174	79	455
2018	25	177	174	105	481
2019	25	177	174	90	466
2020	25	177	174	70	446
2021	25	177	174	56	432
2022	25	177	174	51	427
2023	25	141	174	41	381
2024	25	16	157	25	224
2025	25	16	157	24	222
2026	25	16	157	23	222
2027	25	16	157	26	224

*Two different crystalline cases are analyzed for a second repository. The Crystalline High Case assumes a harder rock structure and at greater depth than does the Crystalline Low Case.

Table C-10 (continued)
Annual Total System Costs
Reference Case - Authorized System (Tuff/Crystalline Low)
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
2028	25	16	157	25	223
2029	25	16	157	24	223
2030	25	16	122	19	182
2031	15	16	17	0	49
2032	15	16	17	0	49
2033	15	16	17	0	49
2034	15	16	17	0	49
2035	15	16	17	0	49
2036	15	16	17	0	49
2037	15	16	17	0	49
2038	15	16	17	0	49
2039	15	16	17	0	49
2040	15	16	17	0	49
2041	15	16	17	0	49
2042	15	16	17	0	49
2043	15	16	17	0	49
2044	15	16	17	0	49
2045	15	16	17	0	49
2046	15	16	17	0	49
2047	15	16	17	0	49
2048	15	11	17	0	44
2049	15	17	17	0	49
2050	15	28	17	0	60
2051	15	33	17	0	66
2052	15	22	17	0	55
2053	15	0	17	0	32
2054	15	0	17	0	32
2055	15	0	17	0	32
2056	15	0	17	0	32
2057	15	0	17	0	32
2058	15	0	31	0	46
2059	15	0	31	0	46
2060	15	0	31	0	46
2061	15	0	31	0	46
2062	15	0	31	0	46
2063	15	0	31	0	46
2064	15	0	31	0	46
2065	15	0	31	0	46
2066	15	0	31	0	46
2067	15	0	31	0	46
2068	15	0	31	0	46
2069	15	0	31	0	46
2070	15	0	31	0	46
2071	15	0	31	0	46
2072	15	0	31	0	46

Table C-18 (continued)
Annual Total System Costs
Reference Case - Authorized System (Tuff/Crystalline Low)
(Millions of 1985 Dollars)

YEAR	O & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
2073	15	0	31	0	46
2074	15	0	31	0	46
2075	15	0	31	0	46
2076	15	0	31	0	46
2077	15	0	31	0	46
2078	15	0	31	0	46
2079	15	0	31	0	46
2080	15	0	31	0	46
2081	15	0	31	0	46
2082	15	0	31	0	46
2083	15	0	31	0	46
2084	15	0	31	0	46
2085	15	0	19	0	34
2086	15	0	28	0	43
2087	15	0	47	0	62
2088	15	0	57	0	72
2089	15	0	38	0	53
TOTALS	9403	6007	6455	1752	23617

ANNUAL AND TOTAL ESTIMATED REVENUES

Mr. Bevill. What is the annual and total estimated revenues in each fiscal year through completion and what charges are assumed in each of these fiscal years?

Mr. Rusche. Annually, the total system life cycle costs of the program are estimated for a number of different media pairs for the first and second repositories. Attached are the current estimated annual costs for the high-cost media pair, the low-cost media pair and the median-cost media pair. Also, attached are the projected annual revenues of the program. The projected revenues are based upon the electricity generation projections contained in the Energy Information Administration's report, "Commercial Nuclear Power: Prospects for the United States and the World," published in September 1985, adjusted to reflect revenues based on net electricity generation.

Calendar Year	Commercial Disposal fee revenue ($ million)		
	Fee on Electrical Generation	One-Time Fee	Total Fee Annual
1984	329*		329
1985	367*	1426*	1793
1986	343[a]	6	349
1987	426	6	432
1988	481	6	487
1989	514	26	540
1990	537	26	563
1991	560	26	586
1992	599	26	625
1993	617	26	643
1994	628	26	653
1995	636	26	662
1996	646	26	672
1997	664	26	690
1998	680	1212	1892
1999	689		689
2000	692		692
2001	703		703
2002	724		724
2003	748		748
2004	773		773
2005	802		802
2006	828		828
2007	846		846
2008	859		859
2009	862		862
2010	870		870
2011	896		896
2012	932		932
2013	969		969
2014	998		998
2015	1029		1029
2016	1061		1061
2017	1091		1091
2018	1118		1118
2019	1147		1147
2020	1171		1171
Totals	27907	2890	30797

*Actual

Note: Excludes interest earnings on nuclear waste fund investments and effect of receipts for disposal of defense atomic wastes.

[a] Ongoing fees reduced by court-mandated rebate

Table C-1
Annual Total System Costs
Reference Case - Authorized System (Basalt/Crystalline High)*
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
1983	226	0	0	0	226
1984	284	0	0	0	284
1985	305	0	0	0	305
1986	493	0	0	0	493
1987	643	0	0	0	643
1988	721	0	0	0	721
1989	631	0	0	0	631
1990	578	41	0	0	619
1991	328	72	0	0	400
1992	242	46	0	0	288
1993	286	205	0	0	491
1994	408	437	0	0	846
1995	418	429	0	0	847
1996	417	400	0	0	817
1997	392	287	0	0	679
1998	308	237	0	28	572
1999	249	156	37	7	450
2000	150	100	65	8	323
2001	106	116	41	34	296
2002	93	184	72	73	422
2003	130	306	335	110	881
2004	115	306	462	76	959
2005	115	306	399	70	890
2006	114	306	296	69	786
2007	114	306	251	68	739
2008	102	306	181	63	652
2009	25	306	154	89	574
2010	25	306	154	64	548
2011	25	306	154	63	547
2012	25	306	154	72	557
2013	25	275	193	63	556
2014	25	275	258	88	646
2015	25	275	258	71	629
2016	25	275	258	95	653
2017	25	275	258	88	647
2018	25	275	258	133	691
2019	25	275	258	119	677
2020	25	275	258	93	651
2021	25	275	258	78	636
2022	25	275	258	84	642
2023	25	207	258	58	547
2024	25	29	232	28	313
2025	25	29	232	36	321
2026	25	29	232	30	315
2027	25	29	232	31	316

*Two different crystalline cases are analyzed for a second repository. The Crystalline High Case assumes a harder rock structure and at greater depth than does the Crystalline Low Case.

Table C-1 (continued)
Annual Total System Costs
Reference Case - Authorized System (Basalt/Crystalline High)
(Millions of 1985 Dollars)

YEAR	O & C	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
2028	25	29	232	31	316
2029	25	29	232	30	316
2030	25	29	176	31	261
2031	15	29	27	0	71
2032	15	29	27	0	71
2033	15	29	27	0	71
2034	15	29	27	0	71
2035	15	29	27	0	71
2036	15	29	27	0	71
2037	15	29	27	0	71
2038	15	29	27	0	71
2039	15	29	27	0	71
2040	15	29	27	0	71
2041	15	29	27	0	71
2042	15	29	27	0	71
2043	15	29	27	0	71
2044	15	29	27	0	71
2045	15	29	27	0	71
2046	15	29	27	0	71
2047	15	29	27	0	71
2048	15	45	27	0	87
2049	15	45	27	0	87
2050	15	45	27	0	87
2051	15	45	27	0	87
2052	15	45	27	0	87
2053	15	45	27	0	87
2054	15	45	27	0	87
2055	15	45	27	0	87
2056	15	45	27	0	87
2057	15	45	27	0	87
2058	15	45	53	0	113
2059	15	45	53	0	113
2060	15	45	53	0	113
2061	15	45	53	0	113
2062	15	45	53	0	113
2063	15	45	53	0	113
2064	15	45	53	0	113
2065	15	45	53	0	113
2066	15	45	53	0	113
2067	15	45	53	0	113
2068	15	45	53	0	113
2069	15	45	53	0	113
2070	15	45	53	0	113
2071	15	45	53	0	113
2072	15	45	53	0	113

Table C-1 (continued)
Annual Total System Costs
Reference Case - Authorized System (Basalt/Crystalline High)
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
2073	15	49	53	0	117
2074	15	49	53	0	117
2075	15	49	53	0	117
2076	15	49	53	0	117
2077	15	49	53	0	117
2078	15	49	53	0	117
2079	15	49	53	0	117
2080	15	49	53	0	117
2081	15	49	53	0	117
2082	15	27	53	0	95
2083	15	40	53	0	108
2084	15	67	53	0	135
2085	15	90	24	0	119
2086	15	53	38	0	104
2087	15	0	59	0	74
2088	15	0	71	0	86
2089	15	0	47	0	62
TOTALS	9403	11339	9478	2870	32289

Table C-5
Annual Total System Costs
Reference Case - Authorized System (Salt/Crystalline High) *
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
1983	226	0	0	0	226
1984	284	0	0	0	284
1985	305	0	0	0	305
1986	493	0	0	0	493
1987	643	0	0	0	643
1988	721	0	0	0	721
1989	631	0	0	0	631
1990	578	38	0	0	616
1991	328	66	0	0	394
1992	242	42	0	0	284
1993	286	189	0	0	475
1994	408	404	0	0	812
1995	418	396	0	0	814
1996	417	370	0	0	787
1997	392	265	0	0	657
1998	308	213	0	23	544
1999	249	139	37	5	430
2000	150	86	65	5	307
2001	106	94	41	23	264
2002	93	144	72	53	362
2003	130	234	335	105	804
2004	115	234	462	63	873
2005	115	234	399	45	792
2006	114	234	296	42	686
2007	114	234	251	47	646
2008	102	234	181	55	572
2009	25	234	154	63	476
2010	25	234	154	56	468
2011	25	234	154	51	464
2012	25	234	154	53	466
2013	25	211	193	64	493
2014	25	211	258	80	575
2015	25	211	258	66	560
2016	25	211	258	72	566
2017	25	211	258	87	581
2018	25	211	258	107	601
2019	25	211	258	105	599
2020	25	211	258	63	558
2021	25	211	258	65	559
2022	25	211	258	57	551
2023	25	161	258	51	495
2024	25	22	232	28	306
2025	25	22	232	33	312
2026	25	22	232	28	307
2027	25	22	232	29	308

*Two different crystalline cases are analyzed for a second repository. The Crystalline High Case assumes a harder rock structure and at greater depth than does the Crystalline Low Case.

Table C-5 (continued)
Annual Total System Costs
Reference Case - Authorized System (Salt/Crystalline High)
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
2028	25	22	232	29	307
2029	25	22	232	28	307
2030	25	22	176	19	242
2031	15	22	27	0	63
2032	15	22	27	0	63
2033	15	22	27	0	63
2034	15	22	27	0	63
2035	15	22	27	0	63
2036	15	22	27	0	63
2037	15	22	27	0	63
2038	15	22	27	0	63
2039	15	22	27	0	63
2040	15	22	27	0	63
2041	15	22	27	0	63
2042	15	22	27	0	63
2043	15	22	27	0	63
2044	15	22	27	0	63
2045	15	22	27	0	63
2046	15	22	27	0	63
2047	15	22	27	0	63
2048	15	39	27	0	81
2049	15	39	27	0	81
2050	15	39	27	0	81
2051	15	24	27	0	66
2052	15	37	27	0	78
2053	15	61	27	0	103
2054	15	73	27	0	115
2055	15	49	27	0	91
2056	15	0	27	0	42
2057	15	0	27	0	42
2058	15	0	53	0	68
2059	15	0	53	0	68
2060	15	0	53	0	68
2061	15	0	53	0	68
2062	15	0	53	0	68
2063	15	0	53	0	68
2064	15	0	53	0	68
2065	15	0	53	0	68
2066	15	0	53	0	68
2067	15	0	53	0	68
2068	15	0	53	0	68
2069	15	0	53	0	68
2070	15	0	53	0	68
2071	15	0	53	0	68
2072	15	0	53	0	68

Table C-5 (continued)
Annual Total System Costs
Reference Case - Authorized System (Salt/Crystalline High)
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
2073	15	0	53	0	68
2074	15	0	53	0	68
2075	15	0	53	0	68
2076	15	0	53	0	68
2077	15	0	53	0	68
2078	15	0	53	0	68
2079	15	0	53	0	68
2080	15	0	53	0	68
2081	15	0	53	0	68
2082	15	0	53	0	68
2083	15	0	53	0	68
2084	15	0	53	0	68
2085	15	0	24	0	39
2086	15	0	35	0	50
2087	15	0	59	0	74
2088	15	0	71	0	86
2089	15	0	47	0	62
TOTALS	9403	7946	9478	1699	28525

Table C-10
Annual Total System Costs
Reference Case - Authorized System (Tuff/Crystalline Low) *
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
1983	226	0	0	0	226
1984	284	0	0	0	284
1985	305	0	0	0	305
1986	493	0	0	0	493
1987	643	0	0	0	643
1988	721	0	0	0	721
1989	631	0	0	0	631
1990	578	23	0	0	601
1991	328	40	0	0	368
1992	242	26	0	0	268
1993	286	115	0	0	401
1994	408	246	0	0	655
1995	418	242	0	0	660
1996	417	226	0	0	642
1997	392	162	0	0	553
1998	308	164	0	26	498
1999	249	118	27	7	402
2000	150	86	48	7	292
2001	106	94	30	34	265
2002	93	129	53	70	345
2003	130	193	248	125	695
2004	115	193	341	79	728
2005	115	193	295	64	666
2006	114	193	219	60	586
2007	114	193	186	59	552
2008	102	193	133	59	487
2009	25	193	107	70	395
2010	25	193	107	55	380
2011	25	193	107	54	379
2012	25	193	107	54	379
2013	25	177	132	62	397
2014	25	177	174	70	445
2015	25	177	174	58	434
2016	25	177	174	79	454
2017	25	177	174	79	455
2018	25	177	174	105	481
2019	25	177	174	90	466
2020	25	177	174	70	446
2021	25	177	174	56	432
2022	25	177	174	51	427
2023	25	141	174	41	381
2024	25	16	157	25	224
2025	25	16	157	24	222
2026	25	16	157	23	222
2027	25	16	157	26	224

*Two different crystalline cases are analyzed for a second repository. The Crystalline High Case assumes a harder rock structure and at greater depth than does the Crystalline Low Case.

Table C-10 (continued)
Annual Total System Costs
Reference Case - Authorized System (Tuff/Crystalline Low)
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
2028	25	16	157	25	223
2029	25	16	157	24	223
2030	25	16	122	19	182
2031	15	16	17	0	49
2032	15	16	17	0	49
2033	15	16	17	0	49
2034	15	16	17	0	49
2035	15	16	17	0	49
2036	15	16	17	0	49
2037	15	16	17	0	49
2038	15	16	17	0	49
2039	15	16	17	0	49
2040	15	16	17	0	49
2041	15	16	17	0	49
2042	15	16	17	0	49
2043	15	16	17	0	49
2044	15	16	17	0	49
2045	15	16	17	0	49
2046	15	16	17	0	49
2047	15	16	17	0	49
2048	15	11	17	0	44
2049	15	17	17	0	49
2050	15	28	17	0	60
2051	15	33	17	0	66
2052	15	22	17	0	55
2053	15	0	17	0	32
2054	15	0	17	0	32
2055	15	0	17	0	32
2056	15	0	17	0	32
2057	15	0	17	0	32
2058	15	0	31	0	46
2059	15	0	31	0	46
2060	15	0	31	0	46
2061	15	0	31	0	46
2062	15	0	31	0	46
2063	15	0	31	0	46
2064	15	0	31	0	46
2065	15	0	31	0	46
2066	15	0	31	0	46
2067	15	0	31	0	46
2068	15	0	31	0	46
2069	15	0	31	0	46
2070	15	0	31	0	46
2071	15	0	31	0	46
2072	15	0	31	0	46

Table C-18 (continued)
Annual Total System Costs
Reference Case - Authorized System (Tuff/Crystalline Low)
(Millions of 1985 Dollars)

YEAR	D & E	FIRST REPOSITORY	SECOND REPOSITORY	TRANS-PORTATION	TOTAL
2073	15	0	31	0	46
2074	15	0	31	0	46
2075	15	0	31	0	46
2076	15	0	31	0	46
2077	15	0	31	0	46
2078	15	0	31	0	46
2079	15	0	31	0	46
2080	15	0	31	0	46
2081	15	0	31	0	46
2082	15	0	31	0	46
2083	15	0	31	0	46
2084	15	0	31	0	46
2085	15	0	19	0	34
2086	15	0	28	0	43
2087	15	0	47	0	62
2088	15	0	57	0	72
2089	15	0	38	0	53
TOTALS	9403	6007	6455	1752	23617

Mr. Bevill. What criteria were used to select sites for the high-level waste repository?

Mr. Rusche. The DOE Siting Guidelines (10 CFR 960) were developed in accordance with the Act to be used in the various steps of the repository site-selection process. Section 112(a) of the Act requires that the Secretary use the Guidelines in considering sites for recommendation. The Guidelines establish performance objectives for a geologic repository system, define the basic technical requirements that candidate sites must meet, and specify how the DOE will implement the Act's site selection process.

Mr. Bevill. Based on these criteria, provide a table that compares the five sites selected for characterization?

Mr. Rusche. Nine potentially acceptable sites for the first high-level nuclear waste repository developed under the Act were identified in the Draft Environmental Assessments (EAs) issued on December 20, 1984. From these nine sites, five will be nominated as suitable for characterization. Final EAs will be issued to accompany the nominated sites. Three of the nominated sites will then be recommended by the Secretary to the President for site characterization.

Attached are preliminary findings for the nine sites being considered for the first high-level nuclear waste repository. The tables indicate findings for all qualifying, favorable, potentially adverse, and disqualifying conditions for all technical guidelines contained in the DOE Siting Guidelines (10 CFR 960). Appendix III of the DOE Siting Guidelines defines the types of findings required for each guideline condition. Findings for the qualifying and disqualifying conditions refer to whether or not the evidence suggests that the condition is met and the degree of certainty associated with the finding based on the available evidence. Two levels of finding, one showing an increased level of confidence over the other, are specified for both the disqualifying and the qualifying conditions. For the disqualifying conditions, a level 1 finding (i.e., the evidence does not (or conversely, does) support a finding that the site is disqualified) must be made at the nomination stage, while a level

2 finding (i.e., the evidence supports a finding that the site is not disqualified and is not likely to be disqualified, or that the site is disqualified or is likely to be disqualified) must be made and supported at the time of recommendation for repository development (site selection). For the qualifying conditions, a level 3 finding (i.e., the evidence does not (or, conversely, does) support a finding that the site is not likely to meet the qualifying condition) must be made at the nomination stage, while a level 4 finding (i.e., the site meets the qualifying condition and is likely to continue to meet it or that the site cannot meet the qualifying condition or is unlikely to be able to meet it) must be made and supported at the recommendation for repository development. Findings for the favorable and potentially adverse conditions indicate whether the condition is present (P) or not present (NP). Those findings which appear in brackets ([]) have been changed since the issuance of the Draft EAs. Where a particular condition is not applicable to the site, NA (Not Applicable) appears for the condition itself and dashes (--) appear for any of its sub-conditions. For example, the fourth favorable condition under geohydrology (4-2-1(B)(4)) refers to waste disposal in the saturated zone while the fifth favorable condition (4-2-1(B)(5)) concerns waste disposal in the unsaturated zone. Thus, condition 4-2-1(B)(4) is not applicable to the Yucca Mountain site and condition 4-2-1(B)(5) is not applicable to the other sites.

PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

GEOHYDROLOGY

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
QC 4 2 1(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)
FC 4-2-1(B)(1)	P	P	P	P	P	P	P	P	P
FC 4 2 1(B)(2)	P	P	P	P	P	P	P	P	NP
FC 4-2-1(B)(3)	NP	NP	NP	NP	NP	NP	NP	NP	NP
FC 4-2 1(B)(4)	NP	P	P	P	P	NP	[NP]	NP	NA
FC 4-2-1(B)(4)(i)	NP	P	NP	NP	P	NP	[NP]	NP	--
FC 4 2 1(B)(4)(ii)	NP	[NP]	P	[NP]	[NP]	NP	NP	NP	--
FC 4-2-1(B)(4)(iii)	NP	NP	NP	P	NP	NP	NP	NP	--
FC 4-2-1(B)(4)(iv)	NP	NP	NP	NP	NP	NP	NP	NP	--
FC 4-2-1(B)(5)	NA	NA	NA	NA	NA	NA	NA	NA	P
FC 4 2 1(B)(5)(i)	--	--	--	--	--	--	--	--	NP
FC 4-2-1(B)(5)(ii)	--	--	--	--	--	--	--	--	P
FC 4 2 1(B)(5)(iii)	--	--	--	--	--	--	--	--	[NP]
FC 4-2-1(B)(5)(iv)	--	--	--	--	--	--	--	--	P
FC 4 2-1(B)(5)(v)	--	--	--	--	--	--	--	--	P
FAC 4-2-1(C)(1)	NP	NP	NP	NP	NP	NP	NP	NP	NP
FAC 4-2-1(C)(2)	NP	NP	NP	NP	NP	NP	NP	NP	P
FAC 4-2-1(C)(3)	P	P	P	P	P	P	P	P	P
DC 4-2-1(D)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)

LEGEND

1(A) The evidence does not support a finding that the site is disqualified

2(A) The evidence supports a finding that the site is not disqualified on the basis of that evidence and is not likely to be disqualified

3(A) The evidence does not support a finding that the site is not likely to meet the qualifying condition

4(A) The evidence supports a finding that the site meets the qualifying condition and is likely to continue to meet the qualifying condition

PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

GEOCHEMISTRY

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
GC 4-2-2(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)
FC 4-2-2(B)(1)	P	P	P	P	P	P	P	P	P
FC 4-2-2(B)(2)	P	P	P	P	P	P	P	P	P
FC 4-2-2(B)(3)	P	P	P	P	P	P	P	P	P
FC 4-2-2(B)(4)	P	P	P	P	P	P	P	P	P
FC 4-2-2(B)(5)	NP	NP	NP	P	NP	NP	NP	NP	P
PAC 4-2-2(C)(1)	NP	NP	NP	NP	NP	NP	NP	NP	NP
PAC 4-2-2(C)(2)	NP	NP	NP	NP	NP	NP	NP	NP	NP
PAC 4-2-2(C)(3)	NP	NP	NP	NP	NP	NP	NP	NP	P

PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

POSTCLOSURE ROCK CHARACTERISTICS

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
GC 4-2-3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)
PE 4-2-3(B)(1)	NP	P	NP	NP	P	P	NP	NP	NP
PE 4-2-3(B)(2)	P	P	P	P	P	P	P	P	P
FAC 4-2-3(C)(1)	NP	NP	NP	NP	NP	P	NP	NP	P
FAC 4-2-3(C)(2)	P	P	P	[NP]	P	P	P	P	NP
FAC 4-2-3(C)(3)	NP	NP	NP	NP	NP	NP	NP	NP	NP

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

[illegible]

PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

DISSOLUTION

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
GC 4-2-6(A)	3(A)	3(A)	3(A)	4(A)	3(A)	3(A)	3(A)	3(A)	4(A)
FC 4-2-6(B)	NP	P	P	P	P	P	P	NP	P
PAC 4-2-6(C)	P	P	P	NP	P	P	P	P	NP
DC 4-2-6(D)	1(A)	1(A)	1(A)	2(A)	1(A)	1(A)	1(A)	1(A)	2(A)

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PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

TECTONICS

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
QC 4-2-7(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)
FC 4-2-7(B)	P	P	P	P	P	P	P	P	[NP]
PAC 4-2-7(C)(1)	P	P	P	P	P	P	P	P	P
PAC 4-2-7(C)(2)	NP	NP	NP	NP	NP	NP	NP	NP	NP
PAC 4-2-7(C)(3)	NP	[P]	NP	[P]	[P]	NP	NP	NP	P
PAC 4-2-7(C)(4)	NP	NP	NP	NP	NP	NP	NP	NP	NP
PAC 4-2-7(C)(5)	NP	NP	NP	NP	NP	NP	NP	NP	NP
PAC 4-2-7(C)(6)	NP	NP	NP	NP	NP	NP	NP	NP	NP
DC 4-2-7(D)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)

PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

HUMAN INTERFERENCE: NATURAL RESOURCES

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
GC 4-2-8-1(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)
FC 4-2-8-1(B)(1)	MP	MP	MP	MP	MP	MP	MP	MP	P
FC 4-2-8-1(B)(2)	P	P	P	MP	P	P	P	P	MP
PAC 4-2-8-1(C)(1)	P	P	P	[P]	P	P	P	P	MP
PAC 4-2-8-1(C)(2)	P	MP	MP	MP	MP	MP	MP	MP	MP
PAC 4-2-8-1(C)(3)	MP	MP	MP	MP	MP	MP	MP	MP	MP
PAC 4-2-8-1(C)(4)	MP	MP	MP	MP	MP	MP	MP	MP	MP
PAC 4-2-8-1(C)(5)	MP	MP	MP	P	MP	MP	MP	MP	MP
DC 4-2-8-1(B)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)

PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

HUMAN INTERFERENCE--SITE OWNERSHIP AND CONTROL

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
GC 4-2-8-2(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)
FC 4-2-8-2(B)	MP	MP	MP	P	MP	MP	MP	MP	MP
PAC 4-2-8-2(C)	[MP]	MP	MP	MP	[MP]	MP	MP	MP	MP

PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

POPULATION DENSITY AND DISTRIBUTION

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
GC 5-2-1(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)
FC 5-2-1(B)(1)	P	P	P	P	P	P	P	P	P
FC 5-2-1(B)(2)	P	P	P	P	P	P	NP	P	P
PAC 5-2-1(C)(1)	P	NP	NP	NP	NP	NP	NP	NP	NP
PAC 5-2-1(C)(2)	NP	NP	NP	NP	NP	P	NP	NP	NP
BC 5-2-1(D)(1)	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]
BC 5-2-1(D)(2)	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]
BC 5-2-1(D)(3)	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[2(A)]	[1(A)]

PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

SITE OWNERSHIP AND CONTROL

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
GC 5-2-2(A)	3(A)	3(A)	3(A)	[3(A)]	3(A)	3(A)	3(A)	3(A)	3(A)
FC 5-2-2(B)	NP	NP	NP	P	NP	NP	NP	NP	NP
P&C 5-2-2(C)	P	P	NP	NP	P	NP	NP	NP	P

PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

METEOROLOGY

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	ZWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
QC 5-2-3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)
FC 5-2-3(B)	P	NP	P	P	NP	P	P	P	P
PAC 5-2-3(C)(1)	P	P	P	P	P	P	P	P	NP
PAC 5-2-3(C)(2)	P	P	P	NP	P	P	P	P	NP

PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

OFFSITE INSTALLATIONS AND OPERATIONS

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
QC 5-2-4(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)
FC 5-2-4(B)	P	NP	NP	NP	NP	P	NP	P	P
PAC 5-2-4(C)(1)	P	NP	P	P	NP	P	P	P	P
PAC 5-2-4(C)(2)	NP	NP	NP	NP	NP	NP	NP	NP	NP
BC 5-2-4(B)(1)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)

PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

ENVIRONMENTAL QUALITY

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
QC 5-2-5(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)
FC 5-2-5(B)(1)	NP	NP	[NP]	P	NP	NP	[NP]	[NP]	P
FC 5-2-5(B)(2)	NP	NP	NP	P	NP	NP	NP	NP	P
PAC 5-2-5(C)(1)	NP	NP	NP	NP	NP	NP	NP	NP	NP
PAC 5-2-5(C)(2)	NP	[P]	NP	NP	[P]	NP	NP	NP	NP
PAC 5-2-5(C)(3)	P	P	NP	NP	P	?	NP	NP	NP
PAC 5-2-5(C)(4)	NP	[P]	NP	NP	[P]	NP	NP	NP	NP
PAC 5-2-5(C)(5)	NP	NP	NP	NP	NP	NP	NP	NP	NP
PAC 5-2-5(C)(6)	NP	NP	NP	NP	NP	NP	NP	NP	NP
BC 5-2-5(D)(1)	1(A)	1(A)	1(A)	[2(A)]	1(A)	1(A)	1(A)	1(A)	[1(A)]
BC 5-2-5(D)(2)	1(A)	1(A)	1(A)	[2(A)]	1(A)	1(A)	1(A)	1(A)	[1(A)]
BC 5-2-5(D)(3)	1(A)	1(A)	1(A)	[2(A)]	1(A)	1(A)	1(A)	1(A)	1(A)

PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

SOCIOECONOMICS

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
QC 5-2-6(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)
FC 5-2-6(B)(1)	P	NP	P	P	NP	P	P	P	P
FC 5-2-6(B)(2)	NP	NP	NP	NP	NP	NP	NP	NP	NP
FC 5-2-6(B)(3)	P	P	P	P	P	P	P	P	P
FC 5-2-6(B)(4)	P	P	P	P	P	P	P	P	P
PAC 5-2-6(C)(1)	[P]	P	NP	NP	P	NP	NP	NP	NP
PAC 5-2-6(C)(2)	P	P	P	P	P	P	P	P	P
PAC 5-2-6(C)(3)	NP	NP	NP	NP	NP	NP	NP	NP	NP
PAC 5-2-6(C)(4)	NP	NP	NP	NP	NP	NP	NP	NP	NP
BC 5-2-6(B)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)

PRELIMINARY FINDINGS FOR NINE POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

TRANSPORTATION

	GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HANFORD	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
GC	5-2-7(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)
FC	5-2-7(B)(1)	P	[NP]	P	P	NP	P	P	P	P
FC	5-2-7(B)(1)(i)	P	NP	NP	P	NP	NP	P	P	[P]
FC	5-2-7(B)(1)(ii)	NP	[NP]	NP	P	NP	NP	NP	NP	P
FC	5-2-7(B)(1)(iii)	P	NP	[NP]	P	NP	[NP]	P	P	NP
FC	5-2-7(B)(1)(iv)	P	NP	P	P	NP	P	P	P	P
FC	5-2-7(B)(1)(v)	P	[NP]	P	P	NP	NP	P	P	P
FC	5-2-7(B)(2)	P	NP	NP	P	NP	NP	P	P	P
FC	5-2-7(B)(3)	P	NP	[P]	[P]	NP	[P]	P	P	P
FC	5-2-7(B)(4)	[NP]	[NP]	[NP]	[NP]	[NP]	[NP]	[NP]	[NP]	P
FC	5-2-7(B)(5)	P	NP	NP	NP	NP	P	NP	P	NP
FC	5-2-7(B)(6)	P	P	P	P	P	P	P	P	P
FC	5-2-7(B)(7)	[P]	[P]	[P]	P	[P]	[P]	[P]	[P]	[P]
FC	5-2-7(B)(8)	P	P	P	P	P	P	P	P	P
FC	5-2-7(B)(9)	[P]	[P]	[P]	P	[P]	[P]	[P]	[P]	P
PAC	5-2-7(C)(1)	NP	P	[P]	NP	P	[P]	NP	NP	P
PAC	5-2-7(C)(2)	NP	P	NP	NP	P	NP	NP	NP	NP
PAC	5-2-7(C)(3)	NP	P	NP	NP	P	[NP]	NP	NP	NP
PAC	5-2-7(C)(4)	[P]	P	NP	NP	P	NP	NP	NP	P

PRELIMINARY FINDINGS FOR SOME POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

SURFACE CHARACTERISTICS

GEOMETRY	CYPRESS CREEK DOME	DAVIS CANYON	BEAR CREEK COUNTY	HANFORD	LAVENDER CANYON	ESCEPION DOME	GRUBER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
GT 0-0-01(A)	D(A)	D(A)	D(A)	[D(A)]	D(A)	D(A)	D(A)	D(A)	D(A)
PD 0-0-02(B)(1)	P	NP	P	P	NP	P	P	P	P
GT 0-0-02(B)(2)	NP	P	P	P	P	P	P	P	P
PWP 0-0-02(C)	P	P	[P]	[P]	P	[P]	[P]	P	[P]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PRELIMINARY FINDINGS FOR SOME POTENTIALLY ACCEPTABLE SITES

(FOR INTERNAL USE ONLY)

RESULT

GUIDELINE	CYPRESS CREEK DOME	DAVIS CANYON	DEAF SMITH COUNTY	HAMPTON	LAVENDER CANYON	RICHTON DOME	SWISHER COUNTY	VACHERIE DOME	YUCCA MOUNTAIN
GE 5-2-10(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)	3(A)
PE 5-2-10(B)(1)	NP	NP	NP	NP	NP	NP	NP	NP	P
PE 5-2-10(B)(2)	NP	NP	[NP]	[NP]	NP	[NP]	[NP]	NP	[NP]
PE 5-2-10(B)(3)	P	P	P	P	P	P	P	P	P
PaG 5-2-10(C)	NP	NP	NP	NP	NP	NP	NP	NP	NP
RC 5-2-10(D)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)	1(A)

Mr. Bevill. What are the most important factors to be considered among these criteria?

Mr. Fusche. Section 3-1-5 of the Siting Guidelines requires that the site comparisons between and among sites must place primary significance on the postclosure guidelines (those dealing with long-term repository performance) and secondary significance on the preclosure guidelines (those dealing with the 35-year construction and operation period). This requirement is reflected in the decision-aiding methodology being used to recommend three sites for characterization.

Both the postclosure and the preclosure guidelines consist of a system guideline or guidelines and corresponding groups of technical guidelines. The postclosure guidelines contain eight technical guidelines in one group. The preclosure guidelines contain eleven technical guidelines separated into three groups that represent, in decreasing order of significance, preclosure radiological safety; environment, socioeconomics, and transportation; and ease and cost of siting, construction, operation, and closure.

Mr. Bevill. What is involved in actual site characterization work? When will it begin and when will it be completed?

Mr. Rusche. The Act and the Department's Siting Guidelines, 10 CFR 960, define site characterization as those activities, whether in the laboratory or field, undertaken to establish the geologic condition of a candidate site relevant to location of a repository. The objectives of the site characterization program are therefore:

1) to establish geologic, hydrologic, and geochemical conditions of a candidate site;
2) to provide data needed for design of the waste package and the repository;
3) to provide data needed for performance assessment of the repository system.

Site characterization work involves gathering necessary information on a recommended site and performing analyses required to develop a complete understanding of the site. Site characterization work commences after approval by the President of the Secretary's recommendation of candidate sites and continues until submittal of a License Application to the Nuclear Regulatory Commission. Before proceeding to sink shafts at any candidate site, a Site Characterization Plan will be prepared, issued to States, affected Tribes, the NRC, and the public. Public hearings will be held in the vicinity of the candidate site to receive comments. We plan to recommend sites for characterization to the President this spring. It is expected that site characterization

will require two to five years to complete after the President's approval of the recommended site.

Currently, the Department is proposing site characterization in 3 different geologic settings: salt, basalt, and tuff (the latter two are volcanic in origin). It is expected that each site will encompass up to 100 acreas on the surface. Shafts will penetrate to the repository horizon. Depending on the geologic setting, the shafts (two per site) will vary in diameter from 6 feet to 12 feet. Again, depending on the site, the depth of the shafts will vary from about 1200 feet to 3500 feet. Underground tunnels will be mined to produce passageways for testing. The passageways will range in length from about 1400 feet to about 5000 feet. In summary, the specific parameters for each site are as follows:

Geologic Setting	Surface Area	Finished Shaft Diameters		Shaft Depth	Tunnel Length
		1st shaft	2nd shaft		
Salt	100 acres	12 ft	12 ft	2250 ft	5000 ft
Basalt	100 acres	6 ft	6 ft	3150 ft	1600 ft
Tuff	100 acres	12 ft	6 ft	1250 ft	1400 ft

Mr.Bevill. Provide a list of all potential waste repository sites in the United States.

Mr. Rusche. Under the Civilian Radioactive Waste Management Program, established by the Nuclear Waste Policy Act of 1982, DOE identified potentially acceptable sites for the first repository program. DOE is preparing to issue Environmental Assessments nominating 5 of the following sites for detailed site characterization:

1. Vacherie Dome site, Louisiana
2. Cypress Creek Dome site, Mississippi
3. Richton Dome site, Mississippi
4. Yucca Mountain site, Nevada
5. Deaf Smith County site, Texas
6. Swisher County site, Texas
7. Davis Canyon site, Utah
8. Lavender Canyon site, Utah
9. Hanford Reservation site, Washington

In addition, DOE has recently proposed the following 12 sites as potentially acceptable sites for a possible repository in crystalline rock (e.g., granite), as identified in the draft Area Recommendation Report:

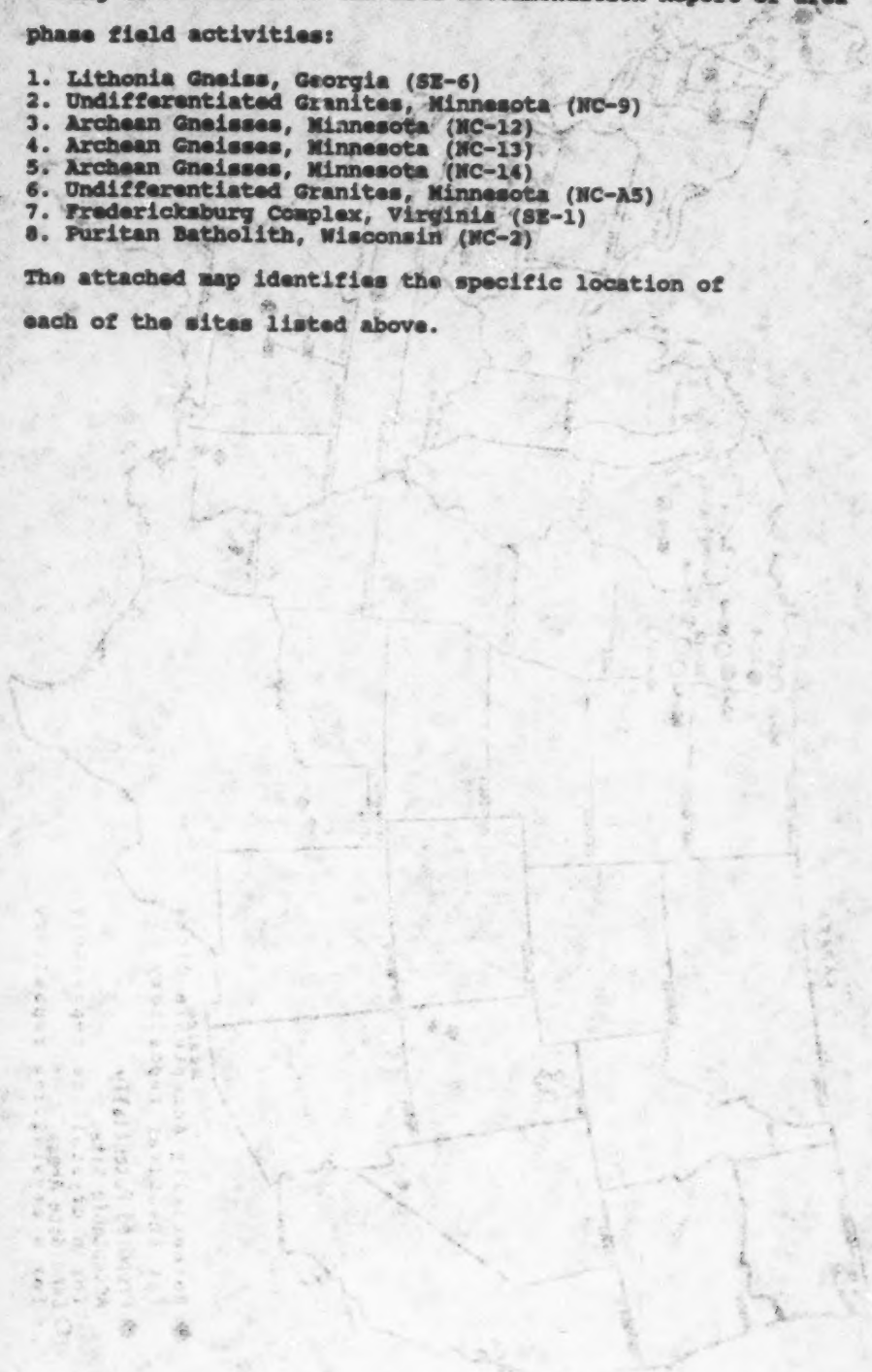
1. Woodland Gneiss Complex, Georgia (SE-7)
2. Bottle Lake Complex, Maine (NE-2)
3. Sebago Lake Batholith, Maine (NE-4)
4. Undifferentiated Granites, Minnesota (NC-6)
5. Undifferentiated Granites, Minnesota (NC-7)
6. Archean Gneisses, Minnesota (NC-10)
7. Cardigan Pluton, New Hampshire (NE-5)
8. Elk River Complex, North Carolina (SE-5)
9. Rolesville Pluton, North Carolina (SE-4)
10. Lovingston Massif, Virginia (SE-2)
11. Virgilina Gneiss, Virginia (SE-3)
12. Wolf River Batholith, Wisconsin (NC-3)

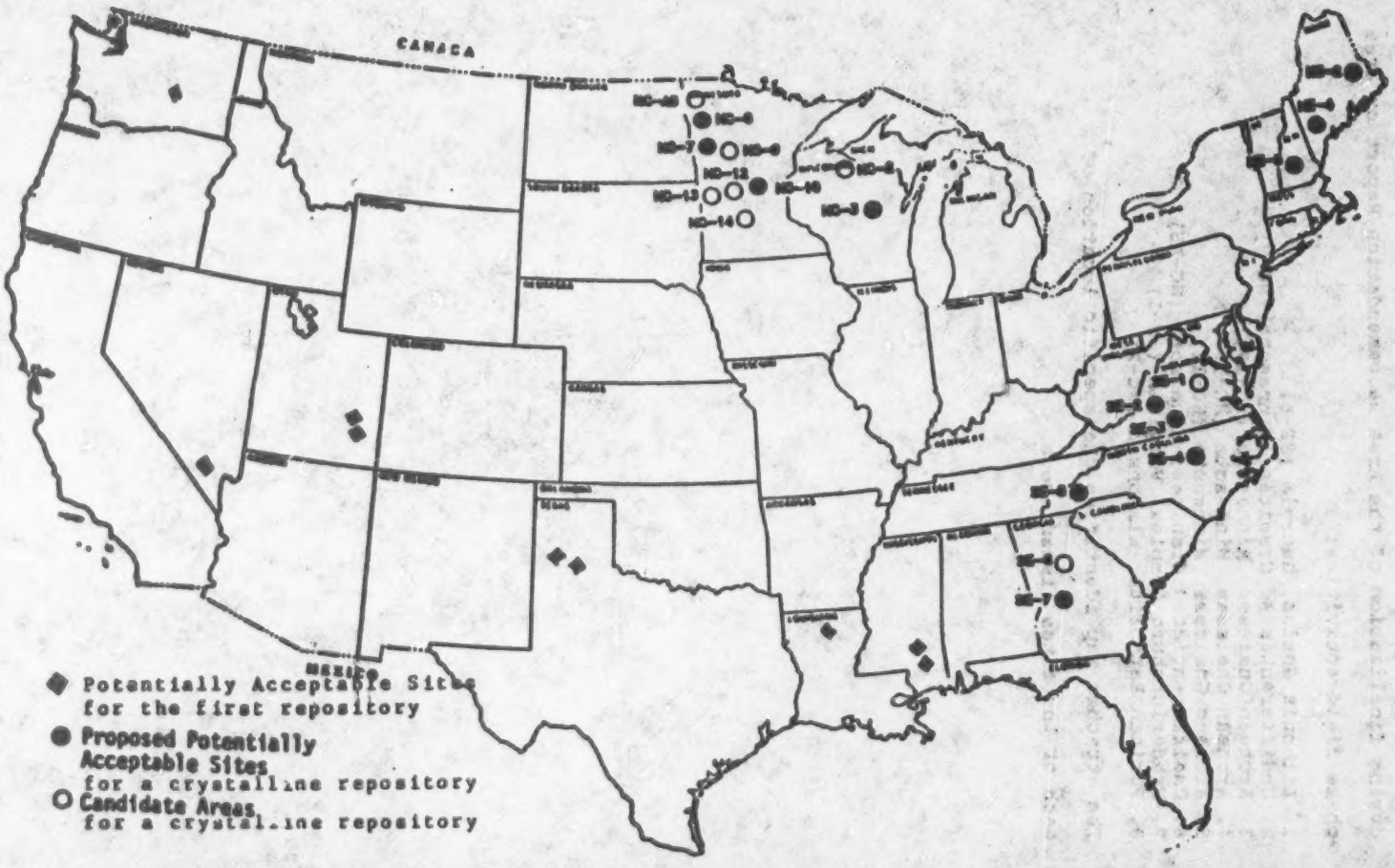
Also, the Crystalline Repository Project has proposed candidate area status to 8 additional rock bodies. The following rock bodies could become potentially acceptable sites, if necessary,

during finalization of the Area Recommendation Report or area phase field activities:

1. Lithonia Gneiss, Georgia (SE-6)
2. Undifferentiated Granites, Minnesota (NC-9)
3. Archean Gneisses, Minnesota (NC-12)
4. Archean Gneisses, Minnesota (NC-13)
5. Archean Gneisses, Minnesota (NC-14)
6. Undifferentiated Granites, Minnesota (NC-A5)
7. Fredericksburg Complex, Virginia (SE-1)
8. Puritan Batholith, Wisconsin (NC-2)

The attached map identifies the specific location of each of the sites listed above.




CANADA
MEXICO
◆ Potentially Acceptable Sites for the first repository
● Proposed Potentially Acceptable Sites for a crystalline repository
○ Candidate Areas for a crystalline repository

Mr. Bevill. Are there any delays in the overall programs that could cause the Department to decide to proceed with construction of a monitored retrievable storage facility?

Mr. Rusche. The Department's decision to propose construction of monitored retrievable storage (MRS) facility is not the result of any delay in overall programs. The Department believes that an MRS facility operating as an integral part of the waste management system, can provide important benefits over a system without an MRS. The main benefits of including the MRS are improvements in system development and system operational flexibility brought about by the earlier development of pre-emplacement functions and the addition of supplemental system storage capability, improved management and control of the transportation system, and the earlier demonstration that facilities constructed and operated by DOE under the Nuclear Waste Policy Act can be responsible citizens and neighbors.

BASIS FOR ESTIMATED REVENUE COLLECTIONS IN FY 1986 AND FY 1987

Mr. Bevill. What is the basis for your estimated revenue collections in FY 1986 and FY 1987?

Mr. Rusche. The FY 1986 and FY 1987 estimated revenue collections are based upon the electricity generation projections contained in the Energy Information Administration's report, "Commercial Nuclear Power: Prospects for the United States and the World," published in September 1985, adjusted to reflect revenues based on net electricity generation.

PLANNED EXPENDITURES FOR COMMUNITY ASSISTANT IN FY 1986 AND FY 1987

Mr. Bevill. How much is planned to be spent in FY 1986 and FY 1987 for community impact assistance? For what?

Mr. Rusche. Approximately $23.9 million is planned in FY 1986 for grants to States, Indian Tribes, and national organizations. In FY 1987, approximately $37.5 million is planned. No funds are planned to be spent for community impact mitigation in FY 1986. In FY 1987, approximately $10.0 million will be utilized for this purpose.

NUCLEAR WASTE DISPOSAL FUND

Mr. Bevill: Do you anticipate any difficulties in meeting the time schedule set in the law? What?

Mr. Rusche: The Department of Energy believes it can meet the long-term milestone in the Nuclear Waste Policy Act of starting disposal operations in January 1998. The Department has had some difficulties in meeting some of the near-term milestones in the Act, such as the issuance of the Siting Guidelines and the final environmental assessments, and the recommendation of sites for characterization. However, DOE decided to expand the process by which these documents were developed in order to ensure all significant issues were considered and addressed. Some future milestones may be missed for similar reasons. As discussed in the OCRWM Mission Plan, there are financial, political, legal or institutional problems which could impede the implementation of the Act. However, DOE does have plans for their resolution. Likewise, DOE has identified both technical information needs and the plans for meeting those needs.

SUFFICIENCY OF ONE MILL/KWH FEE

Mr. Bevill. Is it anticipated that the one mill/kWh fee will be sufficient to meet projected costs? If not, when and how will the Department change the fee?

Mr. Rusche. The Nuclear Waste Policy Act requires that an analysis of the adequacy of 1 mill/kWh fee be performed annually and that a report of the results of that analysis be submitted to the Congress. The report, "Nuclear Waste Fund Fee Adequacy: An Assessment," has been completed and is to be submitted to the Congress in March 1988. It indicates that no adjustment to the fee is expected to be required this year.

[redacted]

[redacted]

[redacted]

[redacted]

Mr. Merrill. Is Louisiana currently under consideration for any form of high-level nuclear waste storage?

Mr. Guedon. A potentially acceptable site has been identified in Louisiana for permanent disposal of high-level waste.

Mr. Sevill. What work remains to be done in the subseabed research program?

Mr. Roache. The program has been directed toward determining, by about 1988, scientific and environmental feasibility based on newly acquired oceanographic and technical data. Planned activities remaining to be done included:

1) at-depth hole closure experiments for emplacement penetrators;

2) at-depth heat transfer and radionuclide migration experiment;

3) acquisition of data regarding physical oceanography and marine biological transfer of radionuclides; and

4) issuance of a report assessing concept feasibility.

Following completion of the determination of concept feasibility, if a decision were made to continue pursuit of the subseabed disposal option, additional work would be required to bring the program through engineering and institutional feasibility, and through design and demonstration. We estimate that a minimum of twenty years would be required for this additional work.

Mr. Sevill. Why were no funds requested to complete that work?

Mr. Roache. No funds were requested to complete the subseabed program because of the funding limitations for research and development programs. With proper closeout, the subseabed program can be reconstituted at a later time if it is deemed necessary.

NRC REIMBURSEMENT

Mr. Bevill. I understand that the Administration is planning to propose egislation that would require that the Nuclear Waste Fund reimburse NRC for its review of a waste repository. Please provide the Committee with your views on this.

Can this proposal be implemented without legislation?

Mr. Rusche. Nuclear utilities are charged a fee by NRC in connection with NRC licensing of their reactors. I believe it is appropriate that the Radioactive Waste Management Program pay similar licensing fees to NRC. It is also my opinion that payment of such fees would be consistent with the full cost recovery provisions of the Nuclear Waste Policy Act (NWPA) and, therefore, could be implemented without further legislative action. A rule-making may be an appropriate process for accomplishing this objective. This issue is currently under review by the Administration.

STATEMENT OF

BEN C. RUSCHE
DIRECTOR
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
U.S. DEPARTMENT OF ENERGY

PRESENTED TO

APPROPRIATIONS COMMITTEE
SUBCOMMITTEE ON ENERGY AND WATER DEVELOPMENT
U.S. HOUSE OF REPRESENTATIVES

MARCH 10, 1986

Mr. Chairman and Members of the Subcommittee:

I am pleased to appear before you today to present the FY 1987 budget for the U.S. Department of Energy's (DOE's) Office of Civilian Radioactive Waste Management. I will highlight the major activities planned for FY 1987 under the Nuclear Waste Fund program, as well as under the Civilian Radioactive Waste Research and Development program and provide a current status of implementation of and plans under the Nuclear Waste Policy Act of 1982 (NWPA). Since the NWPA requires the annual submission of a triennial budget under the Nuclear Waste Fund, in my discussion of the FY 1987 Nuclear Waste Fund program, I will include estimates for FY 1988 and FY 1989.

BUDGET OVERVIEW

The NWPA created the Nuclear Waste Fund which is financed by fees collected from owners and generators of spent nuclear fuel and high-level radioactive waste. The FY 1987 budget request for the Nuclear Waste Fund is $769.3 million, compared to $499.0 million for FY 1986. The Nuclear Waste Fund budget estimate for FY 1988 is $863.0 million and for FY 1989 is $799.2 million.

Research and development (R&D) activities not financed under the Nuclear Waste Fund are funded under the Energy Supply R&D appropriation in a program entitled Civilian Radioactive Waste R&D. The FY 1987 budget request for Civilian Radioactive Waste R&D is $6.5 million, compared to $16.0 million in FY 1986.

The FY 1986 budget request for budget authority funded by the Nuclear Waste Fund is summarized in Table 1. The FY 1987 Departmental budget request for Civilian Radioactive Waste R&D is summarized in Table 2. Under the Nuclear Waste Fund, the increased FY 1987 request will provide for extensive site characterization activities to begin exploratory shaft design and construction and to conduct intensive engineering tests and analyses to support the waste package and repository designs for the first repository. These activities will be conducted at each of the three candidate repository sites approved by the President for site characterization. DOE plans to formally recommend three sites for characterization to the President in Spring 1986.

The increase in FY 1987 will also provide for preparation for site field investigations in crystalline rock under consideration for a second repository and design of the second repository. While construction of a second repository is not authorized by Congress, other activities involving siting and design of a second repository are required under the NWPA.

In addition to an increase in the budget related to the repository activities, the FY 1987 budget request also represents a significant increase over FY 1986 in activities related to Monitored Retrievable Storage (MRS), should Congress adopt the proposal required by Section 141 of the NWPA. The FY 1987

request of $46 million compared to $3.0 million in FY 1986 supports Congressional approval to proceed with activities that are critical to the deployment of an MRS facility. In that proposal, DOE will recommend the construction of an MRS to receive, consolidate and package spent fuel for bulk shipment to a repository.

The program proposed to be funded from the Nuclear Waste Fund puts first priority on the first geologic repository and the associated transportation, integration and management systems. Second priority is given to MRS because of its potential for improving the overall system, followed by a third priority to the second repository siting activity. Neither the MRS nor the second repository is authorized for construction by the NWPA, but it is clear that the MRS offers the earliest and best means for assuring that the objectives of the NWPA are carried out.

TABLE 1

FY 1987 CONGRESSIONAL BUDGET
NUCLEAR WASTE FUND
($in Thousands)

	FY 1986 Approp. 3/	FY 1987 Request
NUCLEAR WASTE FUND		
Repository Development		
o First Repository	$386,050	$541,800
o Second Repository	35,500	78,700
Monitored Retrievable Storage	3,000	46,000
Transportation and Systems Integration	21,275	33,375
Program Management and Technical Support	53,212	69,474
TOTAL	499,037	769,349
Projected Receipts		
o One mill/KHh fee	378,600 1/	420,500 1/
o One-time fee	2,300	2,500
TOTAL	380,900	423,000
Interest Income	118,000 2/	115,000 2/
TOTAL	498,900 2/	538,000 2/
Staffing Full-Time Equivalents (FTE's)	292	292

1/ Based on projected gross nuclear electricity generation reduced by 5% to approximate net nuclear electricity generation as a result of the recent Wisconsin court decision. (Wisconsin Electric Power Company, et al vs Hodel, 83-1066,84-8571 (decided December 6, 1985)). At the time of this budget submission, net nuclear electricity generation projections were not available.

2/ Based on average yield of Treasury security portfolio.

3/ After Gramm-Rudman-Hollings adjustment.

TABLE 2

FY 1987 CONGRESSIONAL BUDGET
ENERGY SUPPLY RESEARCH AND DEVELOPMENT ACTIVITIES
($ in Thousands)

	FY 1986 Approp.	FY 1987 Request
CIVILIAN RADIOACTIVE WASTE R&D		
Spent Fuel Storage Development	$ 8,554	$ 6,300
Alternative Disposal Concepts	7,207	------
Program Direction	303	200
TOTAL	$ 16,064 a/	$ 6,500
Staffing FTE's	5	3

a/ Reflects a general reduction of $30,000; APD Reduction, and a reduction of $631,000 in compliance with the Gramm-Rudman-Hollings Deficit Reduction Act, PL 99-177.

An increase in Transportation and Systems Integration in FY 1987 is also requested. The FY 1987 request of $33.4 million compared to the FY 1986 appropriation of $21.3 million from the Nuclear Waste Fund represents an effort to be initiated during FY 1986 for the private sector to design, fabricate and test prototype casks for DOE to consider in developing transportation casks for shipping spent fuel from reactors directly to a repository or from reactor to an MRS.

The FY 1987 budget request under the Civilian Radioactive Waste R&D program of $6.5 million represents a decrease from the FY 1986 budget of $16.0 million. Essentially, this results from the fact that no funds are being requested for research and development concerning alternatives for permanent disposal of spent fuel and high-level waste. During FY 1986 and previous years, the principal alternative disposal concept funded has been subseabed disposal. Activities related to research and development in alternative disposal concepts called for in Section 222 of the NWPA are not proposed for funding after FY 1986.

NUCLEAR WASTE FUND PROGRAM

With the overview of the FY 1987 budget request in mind, I would like now to give a brief status of the program.

The NWPA calls for DOE to site, design, construct, operate and close the Nation's first geologic repository for spent fuel and high-level waste; to site and design a second repository; to submit a proposal to Congress on the need for and

feasibility of Monitored Retrievable Storage facilities; to develop a transportation system and carry out certain other activities in support of the development of a disposal system. It established a method of disposal, a schedule, technical processes and a funding mechanism -- the Nuclear Waste Fund -- to ensure successful implementation of the NWPA.

Interwoven throughout these activities is the requirement for an extensive system of interactions providing checks and balances to ensure Federal accountability to the States, affected Indian Tribes, the public, the electric utilities, their ratepayers and the Congress. To ensure the accountability of the Federal Government -- specifically, DOE -- to the other parties and concerned citizens, we have on many occasions expanded the interactive process beyond that called for in the NWPA. We have been undertaking steps to ensure that the affected States and Indian Tribes can provide early input to DOE's decisionmaking processes. For example, we have invited affected States and Indian Tribes to participate in the Office of Civilian Radioactive Waste Management internal coordinating groups on socioeconomic and environmental issues.

In spite of these actions, DOE is often criticized by many of the affected parties for not providing the opportunity for "effective" participation. In passing the NWPA, Congress found that "State and public participation in the planning and development of repositories is essential in order to promote public confidence in the safety of disposal of such waste and spent fuel...." My reading of that finding is that not only does the Federal Government have to be accountable to the affected and

interested parties in the Nation, but so do the other participants. An important part of the FY 1987 budget request is to fund participation by States and Indian Tribes.

I do not believe it is the intent of Congress to fund participation to thwart progress in developing a disposal system that will provide reasonable assurance that the public and the environment will be adequately protected from the hazards posed by high-level waste and spent fuel. Effective participation is, I believe, participation for the purpose of ensuring that the resulting decisions will adequately protect the public health, safety and environment.

Repositories

To date, DOE has identified nine potentially acceptable sites for the first repository, prepared draft Environmental Assessments which propose five of these sites as suitable for site characterization and propose three of the five sites for recommendation to the President for site characterization.

A lengthy review process was undertaken in which DOE reviewed approximately 23,000 comments received on the draft Environmental Assessments. Based on comments, we selected one of three mapping methodologies which have been identified in the draft EA's to be used as an aid in the decision process to formally recommend sites for characterization. At the suggestion of several commentors, last fall, we requested the National Academy of Sciences (NAS) Board on Radioactive Waste Management to conduct an independent review of the appropriateness of the

[illegible] methodology -- referred to as the siting selection method.

The SAB Board requested that the methodology, if properly applied, be appropriate, but further recommended that the application of the methodology be validated. Therefore, over the last several months, while EPA has been completing final Environmental Assessments to accompany the formal selection of sites for characterization and applying the ranking methodology in the recommendation decision process, the SAB Board and EPA have met several times on this subject. We expect to have a final review session in late March.

We consider the review by the SAB Board to be quite valuable in ensuring us, as well as the public, that the decisions being made in the siting process are indeed scientifically and technically sound. Based on our discussions with the SAB Board, we currently expect to issue Final Environmental Assessments and formally evaluate and recommend sites for characterization this Spring, around the end of April. The formal evaluation and recommendation will be based on siting guidelines (40 CFR 960), utilizing available geohydrologic, environmental and other relevant information contained in the Environmental Assessments, and will be accompanied by Environmental Assessments and the comments provided by the SAB Board.

The FY 1987 budget request for first repository activities is $541.8 million compared to the FY 1986 appropriation of $363.2 million. This increase is primarily due to the site characterization activities which are planned to commence in FY 1987. The extensive siting evaluation involved in site

Milestones	Calendar Year
o Issue final environmental assessments	April 1986
o Nominate at least five sites and recommend three candidate sites to President for characterization	April 1986
o Issue initial Site Characterization Plans (SCP) for tuff and basalt candidate sites	December 1986
o Issue initial SCP for salt candidate site	May 1987
o Begin construction of first exploratory shaft	May 1987
o Issue Final Environmental Impact Statement	1991
o Recommend first repository site to President	1991
o Recommend first repository site to Congress	1991
o Submit construction application to NRC	1991
o Receive from NRC Construction Authorization	1993-1994
o Begin Phase I Operations	1998

As previously mentioned, the NWPA directs DOE to conduct site investigations for a second repository, although construction of the second repository is contingent upon future Congressional authorization. The process for selecting the second repository site is similar to the process for the first

repository with decision points approximately seven to ten years later than those for the first repository.

For the second repository, DOE may consider sites identified as potentially acceptable but not nominated for the first repository, sites found potentially acceptable from rock formations not previously studied in the first repository selection process and sites characterized but not chosen for the first repository site.

Rock formations not previously studied in the first repository selection process have been crystalline rock. Following national surveys, DOE identified 235 crystalline rockbodies in 17 States in three regions -- the North Central, the Northeast and the Southeast parts of the country.

In the "regional phase" of investigation, DOE collected and assessed publicly available geologic and environmental data, reviewed these data with the States and prepared Regional Environmental and Geologic Characterization Reports for each of the three Regions. In addition, through workshops and other interactions with the crystalline States, DOE prepared a Region-to-Area Screening Methodology to be used for narrowing down the 235 rockbodies to a small number of areas preferred for further study.

On January 16, 1986, following application of the Screening Methodology to the data contained in the Regional Characterization Reports, we issued for public comment a Draft Area Recommendation Report (ARR). The Draft ARR proposes from among the 235 rockbodies in 17 States, 12 potentially acceptable sites in 7 States. The 7 States, listed in alphabetical order, are:

Georgia, Maine, Minnesota, New Hampshire, North Carolina, Virginia and Wisconsin. The Draft ARR also identifies 8 other areas in the same 7 States as suitable for possible further consideration.

During the public comment period on the Draft ARR, DOE will hold more than 70 public briefings and public hearings in all 17 States. After review of the oral and written comments received on the Draft ARR, DOE will issue a final ARR, formally identify potentially acceptable sites in crystalline rock and begin the "area phase" activities for those areas determined potentially acceptable sites for the second repository. Area phase activities include on-site investigations to collect and assess geologic, environmental, socioeconomic and transportation data.

The FY 1987 budget request for second repository activities is $78.7 million compared to the FY 1986 budget appropriation of $35.5 million. The increase is principally to fund preparation for on-site area-phase work which is scheduled to begin in FY 1988 and take approximately three-to-five years. The FY 1988 estimate for second repository activities is $74.2 million and the FY 1989 estimate is $71.5 million.

The major milestones leading to the site recommendation for the second repository are as follows:

Milestones	Calendar Year
o Issue final Region-to-Area Screening Methodology	April 1985
o Issue final regional characterization reports	September 1985
o Issue draft Area Recommendation Report	January 1986
o Issue final Area Recommendation Report	Summer 1986
o Identify Potentially Acceptable Sites	Summer 1986
o Issue final Area Characterization Plan and initiate crystalline rock area phase field investigations	November 1987
o Nominate and recommend sites to President for characterization	1993
o Recommend second repository site to Congress	1999

Monitored Retrievable Storage

The NWPA (Section 141) directs DOE to complete a study of the need for and feasibility of an MRS, and to submit to the Congress a proposal for the construction of one or more MRS facilities. The NWPA specifies that the proposal include a program for siting, development, construction and operation of an MRS facility; site specific designs and cost estimates for the construction of such a facility, should Congress approve its construction; a plan for funding the construction and operation of such a facility; and a plan for integrating such a facility into the overall Federal waste management system.

In spring of 1985, DOE completed its analysis of the need for and feasibility of an MRS facility and announced our

conclusion that such a facility could serve as an integral and important part of the overall waste disposal system. Over the next few months, a proposal for an MRS facility was prepared; and in mid-December, a review draft of the proposal and supporting documents was sent to the Environmental Protection Agency and the Nuclear Regulatory Commission for comment as specified by the Act. Generally favorable comments have been received from both agencies.

DOE has been enjoined from making any proposal or filing any documents with the Congress which rely on the siting studies performed in conjunction with the proposal preparation process. We have appealed the injunction and are hopeful that we will receive a speedy resolution of the legal issues involved so that we can submit the proposal.

Because of the injunction, I am limited in the extent to which I can describe the elements of the proposal. However, I can give the following details:

In our proposal, we will recommend that Congress:

- Approve the construction of an MRS facility at a specific site;
- Limit the storage capacity at the MRS facility to 15,000 metric tons of spent fuel;
- Preclude waste acceptance by the MRS facility until a construction authorization for the first repository is received from the NRC;
- Direct DOE to implement measures responsive to the concerns and recommendations of the host State and local governments; and,
- Direct DOE to implement the program plan accompanying the proposal.

The proposal will be accompanied by NRC and EPA comments.

The proposal contains extensive and unique provisions with regard to State and local involvement in the MRS program. The most innovative and far-reaching element contained in the proposal is the establishment of an MRS Steering Committee to provide a formal mechanism to obtain State and local input, including recommendations and evaluations regarding the design, construction, operation and, eventually, the decommissioning of the MRS facility. This Committee, composed of State and local government representatives of their own choosing, as well as DOE and industry representatives, would provide guidance, conduct evaluations, and, if necessary, recommend corrective actions with regard to the MRS facility. We are proposing that the Committee's involvement extend to a number of areas --

environment, safety and health; transportation; public information; and financial matters.

In accordance with other provisions of the NWPA, should Congress approve proceeding with an MRS facility, we are committed to seeking immediately to enter into a formal Consultation and Cooperation Agreement with the host State.

The FY 1987 budget request supports proceeding with activities that are critical to deployment of an MRS facility. With this in mind, the FY 1987 request for MRS activities is $46 million compared to the FY 1986 budget appropriation of $3 million. These funds would be used primarily for site data collection and analysis, final design of the facility itself, regulatory compliance studies and State liaison activities. The schedule for construction of the MRS allows ten years from the time Congress approves our proceeding, to the start up of operations. The FY 1988 estimate is $50 million and the FY 1989 estimate is $53 million.

Nuclear Waste Fund

In April 1983, DOE adopted a fee of one mill (one-tenth of a cent) per kilowatt hour charged to utilities for all nuclear-generated electricity beginning April 7, 1983, as specified in the NWPA. Revenues collected from the on-going fee by DOE through December 31, 1985, total approximately $880 million.

In addition to spent fuel generated since April 7, 1983, spent fuel or high-level waste generated prior to that date is subject to a fee equivalent to an average charge of one mill per kilowatt hour. Utilities had until June 1985 to decide on one of

three payment options. Those who chose to pay in one lump sum by June 1985, to save interest charges, made payments totalling more than $1.4 billion. This represents more than half of the one-time fee liability of $2.3 billion for civilian nuclear waste in existence prior to April 7, 1983. Following receipt of these monies, DOE reimbursed the U.S. Treasury approximately $265 million, the total amount owed on the appropriated debt transferred to the Nuclear Waste Fund upon enactment of the NWPA.

In April 1985, the President accepted DOE's recommendation to dispose of defense waste in a commercial repository. The Federal Government, therefore, will pay an equivalent fee to that paid by utilities. This use of the repository will generate additional revenue for the Fund. The amount of the additional revenue is presently being determined and, therefore, is not included in our revenue estimates. We are in the final stages of discussions with DOE's Office of Defense Programs to determine an equitable cost-sharing methodology.

The revenue projections based on the one mill per kilowatt hour fee are shown in Table 3.

TABLE 3

NUCLEAR WASTE FUND REVENUE PROJECTIONS
($ in millions)

FY 1983 (actual)	$ 73.6
FY 1984 (actual)	329.5
FY 1985 (actual):	
-One mil/KWh	367.3
-One-time fee	1,427.4
-Interest Earned	38.4
FY 1986	
-One mil/KWh	378.6 a/
-One-time fee	2.3
-Interest Earned	118.0 b/
FY 1987	
-One mil/KWh	420.5 a/
-One-time fee	2.5
-Interest Earned	115.0 b/
FY 1988	
-One mil/KWh	474.5 a/
-One-time fee	17.2
-Interest Earned	105.0 b/
FY 1989	
-One mil/KWh	508.6 a/
-One-time fee	17.5
-Interest Earned	99.0 b/

a/ Based on projected gross nuclear electricity generation reduced by 5% to approximate net nuclear electricity generation as a result of the recent Wisconsin court decision. (Wisconsin Electric Power Company, et al vs. Hodel, 83-1066,84-8571 (decided December 6, 1985)). At the time of this budget submission, net nuclear electricity generation projections were not available.

b/ Based on average yield of Treasury security portfolio.

Transportation and Systems Integration

The FY 1987 budget request for activities associated with Transportation and Systems Integration is $33.4 million. The FY 1988 estimate is $33.8 million; and the FY 1989 estimate is $31.0 million.

The funding request for FY 1987 provides for development of adequate transportation and integrated systems for the shipping and management of nuclear waste among the various components of the disposal system.

The FY 1987 major activities include funding for the private sector to design, fabricate and test prototype casks for truck, rail and barge transport based on competitive procurements. Work will be continued to support institutional programs, environmental and economic analysis and technology development, data systems and testing and engineering development and systems integration.

The FY 1988 and FY 1989 estimates of $33.8 million and $31.0 million, respectively, would fund the continuation of these efforts.

Program Management and Support

The FY 1987 budget request for program management and technical support is $69.5 million. The FY 1988 estimate is $72.7 million; and the FY 1989 estimate is $72.2 million.

The FY 1987 funding level of $69.5 million provides technical support for waste management activities including (a) technical support integration, (b) development of standard materials characterization methods by the Material Characterization Center, and (c) supporting studies including fund management activities.

This funding level provides for a sustained staffing level from FY 1986 to FY 1987 of 292 full-time equivalent positions at headquarters and in the Operations Offices for fund management, site investigation, technology development and institutional liaison associated with the technical management of the repository, MRS (if approved), supporting programs and the management of the Nuclear Waste Fund.

The FY 1988 and FY 1989 estimates of $72.7 million and $72.2 million, respectively, will provide for program management and technical support associated with site characterization activities at three candidate repository sites, intensified siting efforts in the second repository program, a vigorous MRS program and increasing efforts in transportation systems development. Major emphasis will continue on developing an integrated cost-effective waste disposal system providing full protection of public health and safety and the environment.

CIVILIAN RADIOACTIVE WASTE R&D PROGRAM

Development and demonstration activities under the Civilian Radioactive Waste R&D Program are funded from the General Fund rather than funds collected from the utilties and deposited into the Nuclear Waste Fund.

The FY 1987 budget request for the Civilian Radioactive Waste R&D activities is $6.5 million compared to $16.0 million in FY 1986.

I would like to briefly discuss the strategy and highlight the activities which we plan to undertake in FY 1987.

Strategy

DOE's Civilian Radioactive Waste R&D program efforts are to utilize all means directed or available through the Act or other authority to encourage and expedite the availability of licensed new at-reactor storage technologies. No funds are requested for research and development concerning alternative means and technologies for the permanent disposal of high-level radioactive wastes, including the subseabed disposal concept. Activities to implement Section 222 -- alternative means of disposal -- are not proposed after FY 1986.

Spent Fuel Storage R&D

DOE's spent fuel storage development program is intended to encourage and expedite the most efficient use of existing storage facilities and the addition of new, licensed capacity in a timely fashion. The FY 1987 budget request to support these activities is $6.3 million compared to $8.5 in FY 1986.

Activities in FY 1987 will include continued dry storage cask testing as part of a cooperative agreement with Virginia Power; completion of preliminary tests and analyses on a transportable cask as part of a cooperative agreement with Carolina Power and Light; and initiation of rod consolidation demonstrations of spent fuel as part of a cooperative agreement with Northeast Utilities Services Company. In addition, we plan to continue cooperative activities in information exchange regarding spent fuel storage and disposal with non-nuclear weapon states and to continue to participate in international activities with the International Atomic Energy Agency, the Nuclear Energy Agency and the Federal Republic of Germany.

We do not plan to continue investigations into alternative disposal concepts, including subseabed disposal, nor generic methods and support studies beyond those international information exchanges and international involvement discussed under spent fuel storage development.

Program Direction

The FY 1987 budget request for program direction is $.2 million. At this level, three full-time equivalents would be funded to manage the Civilian Radioactive Waste R&D programs. Included are administrative and technical personnel who manage a broad range of activities such as: research, development, demonstration, industrial involvement and international programs.

In summary, Mr. Chairman, the FY 1987 budget request for spending authority under the Nuclear Waste Fund and for appropriations under the Civilian Radioactive Waste R&D budget are designed to carry out an integrated waste managment program in an efficient and effective manner and to achieve the 1998 mandate of the Nuclear Waste Policy Act, that is, to have in place a comprehensive and functional waste disposal system to begin receiving spent fuel.

This concludes my written testimony.

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BEN C. RUSCHE
TALKING POINTS
HOUSE APPROPRIATIONS
SUBCOMMITTEE ON ENERGY AND WATER DEVELOPMENT
MARCH 10, 1986

- o I am pleased to appear before you today to present the FY 1987 budget fcr DOE's Office of Civilian Radioactive Waste Management.
- o I have submitted a rather lengthy statement which I would like to have submitted for the record and now take just a few minutes to highlight our request.
- o Our budget request is under two funding areas:
  - The Nuclear Waste Fund financed by fees collected from owners and generators of spent nuclear fuel and high-level radioactive waste; and
  - The Civilian Radioactive Waste Research and Development program funded from the General Fund.

  Since the Nuclear Waste Policy Act of 1982 requires the submission of a triennial budget under the Nuclear Waste Fund, our detailed budget request and formal statement provides estimates for FY 1988 and FY 1989.
- o I will not in this brief overview discuss those estimates, but will be glad to answer any questions you may have on those estimates.
- o Our request for FY 87 under the Fund is $769.3 million compared to $499.0 million in FY 86.
- o Our request under the Civilian R&D program is $6.5 million compared to $16.0 million in FY 1986.

NUCLEAR WASTE FUND

- The request under the Fund is summarized in Table 1 of my formal statement. Briefly, it is as follows:

First Repository

- The FY 87 request for first repository activities is $541.8 million compared to the FY 1986 appropriation of $386.0 million.
- This increase will provide for extensive site characterization activities to begin exploratory shaft design and construction and to conduct intensive engineering tests and analyses to support the waste package and repository designs for the first repository.
- We expect to issue final environmental assessments, nominate and then recommend to the President, hopefully, around the end of April, three sites for site characterization.
- As part of this process, we are planning to meet with the National Academy of Sciences the end of March to discuss their conclusions with regard to our application of a ranking methodology in arriving at the recommendation of three sites for characterization.
- The major milestones associated with first repository activities are provided on page 11 of my formal statement.

Second Repository

- The Act directs DOE to conduct site investigations for a second repository, although construction of a second repository is contingent upon future Congressional authorization.

- The FY 87 request in the budget under the category entitled second repository is $78.7 million compared to the FY 86 appropriation of $35.5 million.
- That category is really a misnomer, since clearly for the second repository, DOE may consider:
  - sites identified as potentially acceptable but not nominated for the first repository;
  - sites characterized but not chosen for the first repository site; and
  - sites found potentially acceptable from rock formations not previously studied in the first repository selection process.
- It is this last category for which $78.7 million is requested and is principally to fund preparation for on-site area-phase work which is scheduled to begin in FY 1988.
- We are currently in the midst of conducting more than 70 public briefings and public hearings in North Central, Northeastern and Southeastern States to receive comments on a Draft Area Recommendation Report which proposes 12 potentially acceptable sites for which we would like to begin preliminary field work. Those proposed areas are:
  - 1 in Georgia
  - 2 in Maine
  - 3 in Minnesota
  - 1 in New Hampshire
  - 2 in North Carolina
  - 2 in Virginia
  - 1 in Wisconsin

Monitored Retrievable Storage

- o I am rather limited in what I can say about the MRS, other than:
  - As required by Section 141 of the Act, we have completed the proposal to Congress on the need for and feasibility of MRS.
  - We believe MRS is an integral component of a waste disposal system.
  - The FY 87 budget requests $46 million compared to $3 million appropriated in FY 86 and, should we receive Congressional authorization and appropriation to proceed, would be used primarily for site data collection and analysis, final design, regulatory compliance studies and State liaison activities.
  - We are abiding by a court injunction and, therefore, we have not submitted the proposal to Congress.
  - DOE has appealed the lower court's order and injunction and has been granted an expedited schedule by the court of appeals. We hope to have a resolution of the legal issues involved by summer.
  - Therefore, I want to make it clear that what I say here today is not the formal Department proposal for an MRS facility.

Transportation and Systems Integration

- o In FY 87, we are requesting for Transportation and Systems Integration $33.4 million compared to $21.3 million in FY86.
- o The major activities for FY 87 include funding for the

private sector to design, fabricate and test prototype casks for transport from reactor to either an MRS or directly to a repository.

Staffing (Program Management and Technical Support)

- The FY 87 request under Program Management and Technical Support will provide for a sustained staffing level from this year to next year of 292 full-time equivalent positions at headquarters and in the project offices to fund management, site investigation, technology development and institutional liaison.

CIVILIAN RADIOACTIVE WASTE R&D PROGRAM

- DOE's Civilian Radioactive Waste R&D program efforts are to encourage and expedite the availability of licensed new at-reactor storage technologies.
- Under the R&D program and from the General Fund, we are requesting on $6.5 million compared to $16.0 million in FY 86.
- We are requesting no funds for R&D concerning alternative means of disposal described in Section 222 of the Act, but instead are concencentrating on cooperative agreements with utilities to demonstrate, for example, rod consolidation and dry storage technologies.
- For program direction, we are requesting only $ .2 million and are requesting only 3 full-time equivalent positions as compared to 5 in FY 86.

CONCLUSION

o This concludes my overview. I would be happy to address any questions you may have or expand on our budget request.

****

E R R A T A S H E E T

Since the FY 87 budget testimony was originally prepared, DOE has been enjoined from making any proposal or filing any documents with Congress which rely on the MRS siting study conducted by the Department in conjunction with the preparation of the MRS proposal. Therefore, the testimony must be modified to delete all references to those portions of the proposal preparation process or the proposal itself which identify the preferred site.

Attached are:

- o A new page 3
- o A new page 4 to add footnote 3
- o A new page 15 which replaces old pages 15 and 16
- o A new page 17 and 18.

The corrected copy will be submitted for the record.

request of $46 million compared to $3.0 million in FY 1986 supports Congressional approval to proceed with activities that are critical to the deployment of an MRS facility. In that proposal, DOE will recommend the construction of an MRS to receive, consolidate and package spent fuel for bulk shipment to a repository.

The program proposed to be funded from the Nuclear Waste Fund puts first priority on the first geologic repository and the associated transportation, integration and management systems. Second priority is given to MRS because of its potential for improving the overall system, followed by a third priority to the second repository siting activity. Neither the MRS nor the second repository is authorized for construction by the NWPA, but it is clear that the MRS offers the earliest and best means for assuring that the objectives of the NWPA are carried out.

TABLE 1

FY 1987 CONGRESSIONAL BUDGET
NUCLEAR WASTE FUND
($in Thousands)

	FY 1986 Approp. 3/	FY 1987 Request
NUCLEAR WASTE FUND		
Repository Development		
o First Repository	$386,050	$541,800
o Second Repository	35,500	78,700
Monitored Retrievable Storage	3,000	46,000
Transportation and Systems Integration	21,275	33,375
Program Management and Technical Support	53,212	69,474
TOTAL	499,037	769,349
Projected Receipts		
o One mill/KHh fee	378,600 1/	420,500 1/
o One-time fee	2,300	2,500
TOTAL	380,900	423,000
Interest Income	118,000 2/	115,000 2/
TOTAL	498,900 2/	538,000 2/
Staffing Full-Time Equivalents (FTE's)	292	292

1/ Based on projected gross nuclear electricity generation reduced by 5% to approximate net nuclear electricity generation as a result of the recent Wisconsin court decision. (Wisconsin Electric Power Company, et al vs Hodel, 83-1066,84-8571 (decided December 6, 1985)). At the time of this budget submission, net nuclear electricity generation projections were not available.

2/ Based on average yield of Treasury security portfolio.

3/ After Gramm-Rudman-Hollings adjustment.

conclusion that such a facility could serve as an integral and important part of the overall waste disposal system. Over the next few months, a proposal for an MRS facility was prepared; and in mid-December, a review draft of the proposal and supporting documents was sent to the Environmental Protection Agency and the Nuclear Regulatory Commission for comment as specified by the Act. Generally favorable comments have been received from both agencies.

DOE has been enjoined from making any proposal or filing any documents with the Congress which rely on the siting studies performed in conjunction with the proposal preparation process. We have appealed the injunction and are hopeful that we will receive a speedy resolution of the legal issues involved so that we can submit the proposal.

Because of the injunction, I am limited in the extent to which I can describe the elements of the proposal. However, I can give the following details:

In our proposal, we will recommend that Congress:

- Approve the construction of an MRS facility at a specific site;
- Limit the storage capacity at the MRS facility to 15,000 metric tons of spent fuel;
- Preclude waste acceptance by the MRS facility until a construction authorization for the first repository is received from the NRC;
- Direct DOE to implement measures responsive to the concerns and recommendations of the host State and local governments; and,
- Direct DOE to implement the program plan accompanying the proposal.

The proposal will be accompanied by NRC and EPA comments.

The proposal contains extensive and unique provisions with regard to State and local involvement in the MRS program. The most innovative and far-reaching element contained in the proposal is the establishment of an MRS Steering Committee to provide a formal mechanism to obtain State and local input, including recommendations and evaluations regarding the design, construction, operation and, eventually, the decommissioning of the MRS facility. This Committee, composed of State and local government representatives of their own choosing, as well as DOE and industry representatives, would provide guidance, conduct evaluations, and, if necessary, recommend corrective actions with regard to the MRS facility. We are proposing that the Committee's involvement extend to a number of areas --

environment, safety and health; transportation; public information; and financial matters.

In accordance with other provisions of the NWPA, should Congress approve proceeding with an MRS facility, we are committed to seeking immediately to enter into a formal Consultation and Cooperation Agreement with the host State.

The FY 1987 budget request supports proceeding with activities that are critical to deployment of an MRS facility. With this in mind, the FY 1987 request for MRS activities is $46 million compared to the FY 1986 budget appropriation of $3 million. These funds would be used primarily for site data collection and analysis, final design of the facility itself, regulatory compliance studies and State liaison activities. The schedule for construction of the MRS allows ten years from the time Congress approves our proceeding, to the start up of operations. The FY 1988 estimate is $50 million and the FY 1989 estimate is $53 million.

Nuclear Waste Fund

In April 1983, DOE adopted a fee of one mill (one-tenth of a cent) per kilowatt hour charged to utilities for all nuclear-generated electricity beginning April 7, 1983, as specified in the NWPA. Revenues collected from the on-going fee by DOE through December 31, 1985, total approximately $880 million.

In addition to spent fuel generated since April 7, 1983, spent fuel or high-level waste generated prior to that date is subject to a fee equivalent to an average charge of one mill per kilowatt hour. Utilities had until June 1985 to decide on one of

STATEMENT OF

BEN C. RUSCHE
DIRECTOR
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
U.S. DEPARTMENT OF ENERGY

PRESENTED TO

APPROPRIATIONS COMMITTEE
SUBCOMMITTEE ON ENERGY AND WATER DEVELOPMENT
U.S. HOUSE OF REPRESENTATIVES

MARCH 10, 1986

Mr. Chairman and Members of the Subcommittee:

I am pleased to appear before you today to present the FY 1987 budget for the U.S. Department of Energy's (DOE's) Office of Civilian Radioactive Waste Management. I will highlight the major activities planned for FY 1987 under the Nuclear Waste Fund program, as well as under the Civilian Radioactive Waste Research and Development program and provide a current status of implementation of and plans under the Nuclear Waste Policy Act of 1982 (NWPA). Since the NWPA requires the annual submission of a triennial budget under the Nuclear Waste Fund, in my discussion of the FY 1987 Nuclear Waste Fund program, I will include estimates for FY 1988 and FY 1989.

BUDGET OVERVIEW

The NWPA created the Nuclear Waste Fund which is financed by fees collected from owners and generators of spent nuclear fuel and high-level radioactive waste. The FY 1987 budget request for the Nuclear Waste Fund is $769.3 million, compared to $499.0 million for FY 1986. The Nuclear Waste Fund budget estimate for FY 1988 is $863.0 million and for FY 1989 is $799.2 million.

Research and development (R&D) activities not financed under the Nuclear Waste Fund are funded under the Energy Supply R&D appropriation in a program entitled Civilian Radioactive Waste R&D. The FY 1987 budget request for Civilian Radioactive Waste R&D is $6.5 million, compared to $16.0 million in FY 1986.

The FY 1986 budget request for budget authority funded by the Nuclear Waste Fund is summarized in Table 1. The FY 1987 Departmental budget request for Civilian Radioactive Waste R&D is summarized in Table 2. Under the Nuclear Waste Fund, the increased FY 1987 request will provide for extensive site characterization activities to begin exploratory shaft design and construction and to conduct intensive engineering tests and analyses to support the waste package and repository designs for the first repository. These activities will be conducted at each of the three candidate repository sites approved by the President for site characterization. DOE plans to formally recommend three sites for characterization to the President in Spring 1986.

The increase in FY 1987 will also provide for preparation for site field investigations in crystalline rock under consideration for a second repository and design of the second repository. While construction of a second repository is not authorized by Congress, other activities involving siting and design of a second repository are required under the NWPA.

In addition to an increase in the budget related to the repository activities, the FY 1987 budget request also represents a significant increase over FY 1986 in activities related to Monitored Retrievable Storage (MRS), should Congress adopt the proposal required by Section 141 of the NWPA. The FY 1987

request of $46.0 million compared to $3.0 million in FY 1986 supports Congressional approval to proceed with activities that are critical to the deployment of an MRS facility in Tennessee. In that proposal, DOE will recommend the construction of an MRS in Tennessee to receive, consolidate and package spent fuel for bulk shipment to a repository. I will later in my testimony discuss the details of the proposal.

The program proposed to be funded from the Nuclear Waste Fund puts first priority on the first geologic repository and the associated transportation, integration and management systems. Second priority is given to MRS because of its potential for improving the overall system, followed by a third priority to the second repository siting activity. Neither the MRS nor the second repository is authorized for construction by the NWPA, but it is clear that the MRS offers the earliest and best means for assuring that the objectives of the NWPA are carried out.

TABLE 1

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($in Thousands)

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TOTAL	498,900 2/	538,000 2/
Staffing Full-Time Equivalents (FTE's)	292	292

1/ Based on projected gross nuclear electricity generation reduced by 5% to approximate net nuclear electricity generation as a result of the recent Wisconsin court decision. (Wisconsin Electric Power Company, et al vs Hodel, 83-1066,84-8571 (decided December 6, 1985)). At the time of this budget submission, net nuclear electricity generation projections were not available.

2/ Based on average yield of Treasury security portfolio.

TABLE 2

FY 1987 CONGRESSIONAL BUDGET
ENERGY SUPPLY RESEARCH AND DEVELOPMENT ACTIVITIES
($ in Thousands)

	FY 1986 Approp.	FY 1987 Request
CIVILIAN RADIOACTIVE WASTE R&D		
Spent Fuel Storage Development	$ 8,554	$ 6,300
Alternative Disposal Concepts	7,207	------
Program Direction	303	200
TOTAL	$ 16,064 a/	$ 6,500
Staffing FTE's	5	3

a/ Reflects a general reduction of $30,000; APD Reduction, and a reduction of $631,000 in compliance with the Gramm-Rudman-Hollings Deficit Reduction Act, PL 99-177.

An increase in Transportation and Systems Integration in FY 1987 is also requested. The FY 1987 request of $33.4 million compared to the FY 1986 appropriation of $21.3 million from the Nuclear Waste Fund represents an effort to be initiated during FY 1986 for the private sector to design, fabricate and test prototype casks for DOE to consider in developing transportation casks for shipping spent fuel from reactors directly to a repository or from reactor to an MRS.

The FY 1987 budget request under the Civilian Radioactive Waste R&D program of $6.5 million represents a decrease from the FY 1986 budget of $16.0 million. Essentially, this results from the fact that no funds are being requested for research and development concerning alternatives for permanent disposal of spent fuel and high-level waste. During FY 1986 and previous years, the principal alternative disposal concept funded has been subseabed disposal. Activities related to research and development in alternative disposal concepts called for in Section 222 of the NWPA are not proposed for funding after FY 1986.

NUCLEAR WASTE FUND PROGRAM

With the overview of the FY 1987 budget request in mind, I would like now to give a brief status of the program.

The NWPA calls for DOE to site, design, construct, operate and close the Nation's first geologic repository for spent fuel and high-level waste; to site and design a second repository; to submit a proposal to Congress on the need for and

feasibility of Monitored Retrievable Storage facilities; to develop a transportation system and carry out certain other activities in support of the development of a disposal system. It established a method of disposal, a schedule, technical processes and a funding mechanism -- the Nuclear Waste Fund -- to ensure successful implementation of the NWPA.

Interwoven throughout these activities is the requirement for an extensive system of interactions providing checks and balances to ensure Federal accountability to the States, affected Indian Tribes, the public, the electric utilities, their ratepayers and the Congress. To ensure the accountability of the Federal Government -- specifically, DOE -- to the other parties and concerned citizens, we have on many occasions expanded the interactive process beyond that called for in the NWPA. We have been undertaking steps to ensure that the affected States and Indian Tribes can provide early input to DOE's decisionmaking processes. For example, we have invited affected States and Indian Tribes to participate in the Office of Civilian Radioactive Waste Management internal coordinating group on socioeconomic and environmental issues.

In spite of these actions, DOE is often criticized by many of the affected parties for not providing the opportunity for "effective" participation. In passing the NWPA, Congress found that "State and public participation in the planning and development of repositories is essential in order to promote public confidence in the safety of disposal of such waste and spent fuel...." My reading of that finding is that not only does the Federal Government have to be accountable to the affected and

interested parties in the Nation, but so do the other participants. An important part of the FY 1987 budget request is to fund participation by States and Indian Tribes.

I do not believe it is the intent of Congress to fund participation to thwart progress in developing a disposal system that will provide reasonable assurance that the public and the environment will be adequately protected from the hazards posed by high-level waste and spent fuel. Effective participation is, I believe, participation for the purpose of ensuring that the resulting decisions will adequately protect the public health, safety and environment.

Repositories

To date, DOE has identified nine potentially acceptable sites for the first repository, prepared draft Environmental Assessments which propose five of those sites as suitable for site characterization and propose three of the five sites for recommendation to the President for site characterization.

A lengthy review process was undertaken in which DOE reviewed approximately 23,000 comments received on the draft Environmental Assessments. Based on comments, we selected one of three ranking methodologies which have been identified in the draft EA's to be used in the decision process to formally recommend sites for characterization. At the suggestion of several commentors, last fall, we requested the National Academy of Sciences (NAS) Board on Radioactive Waste Management to conduct an independent review of the appropriateness of the

ranking methodology -- referred to as the utility estimation method.

The NAS Board responded that the methodology, if properly applied, is appropriate, but further recommended that the application of the methodology be reviewed. Therefore, over the last several months, while DOE has been completing final Environmental Assessments to accompany the formal nomination of sites for characterization and applying the ranking methodology in the recommendation decision process, the NAS Board and DOE have met several times on this subject. We expect to have a final review session in late March.

We consider the review by the NAS Board to be quite valuable in ensuring us, as well as the public, that the decisions being made in the siting process are indeed scientifically and technically sound. Based on our discussions with the NAS Board, we currently expect to issue final Environmental Assessments and formally nominate and recommend sites for characterization this Spring, around the end of April. The formal nomination and recommendation will be based on siting guidelines (10 CFR 960), utilizing available geotechnical, environmental and other relevant information contained in the Environmental Assessments, and will be accompanied by Environmental Assessments and the comments provided by the NAS Board.

The FY 1987 budget request for first repository activities is $541.8 million compared to the FY 1986 appropriation of $386.0 million. This increase is primarily due to the site characterization activities which are planned to commence in FY 1987. The extensive site evaluation involved in site

characterization includes construction of deep, exploratory shafts at the three sites approved for site characterization and in situ testing. DOE is planning two shafts at each site. Shaft construction at the three sites will take approximately two years with in situ tests scheduled to start in FY 1989.

The FY 1988 budget estimate for first repository activities is $632.4 million and the FY 1989 budget estimate is $571.5 million.

Major program milestones associated with the first repository are:

Milestones	Calendar Year
o Issue final environmental assessments	April 1986
o Nominate at least five sites and recommend three candidate sites to President for characterization	April 1986
o Issue initial Site Characterization Plans (SCP) for tuff and basalt candidate sites	December 1986
o Issue initial SCP for salt candidate site	May 1987
o Begin construction of first exploratory shaft	May 1987
o Issue Final Environmental Impact Statement	1991
o Recommend first repository site to President	1991
o Recommend first repository site to Congress	1991
o Submit construction application to NRC	1991
o Receive from NRC Construction Authorization	1993-1994
o Begin Phase I Operations	1998

As previously mentioned, the NWPA directs DOE to conduct site investigations for a second repository, although construction of the second repository is contingent upon future Congressional authorization. The process for selecting the second repository site is similar to the process for the first

repository with decision points approximately seven to ten years later than those for the first repository.

For the second repository, DOE may consider sites identified as potentially acceptable but not nominated for the first repository, sites found potentially acceptable from rock formations not previously studied in the first repository selection process and sites characterized but not chosen for the first repository site.

Rock formations not previously studied in the first repository selection process have been crystalline rock. Following national surveys, DOE identified 235 crystalline rockbodies in 17 States in three regions -- the North Central, the Northeast and the Southeast parts of the country.

In the "regional phase" of investigation, DOE collected and assessed publicly available geologic and environmental data, reviewed these data with the States and prepared Regional Environmental and Geologic Characterization Reports for each of the three Regions. In addition, through workshops and other interactions with the crystalline States, DOE prepared a Region-to-Area Screening Methodology to be used for narrowing down the 235 rockbodies to a small number of areas preferred for further study.

On January 16, 1986, following application of the Screening Methodology to the data contained in the Regional Characterization Reports, we issued for public comment a Draft Area Recommendation Report (ARR). The Draft ARR proposes from among the 235 rockbodies in 17 States, 12 potentially acceptable sites in 7 States. The 7 States, listed in alphabetical order, are:

Georgia, Maine, Minnesota, New Hampshire, North Carolina, Virginia and Wisconsin. The Draft ARR also identifies 8 other areas in the same 7 States as suitable for possible further consideration.

During the public comment period on the Draft ARR, DOE will hold more than 70 public briefings and public hearings in all 17 States. After review of the oral and written comments received on the Draft ARR, DOE will issue a final ARR, formally identify potentially acceptable sites in crystalline rock and begin the "area phase" activities for those areas determined potentially acceptable sites for the second repository. Area phase activities include on-site investigations to collect and assess geologic, environmental, socioeconomic and transportation data.

The FY 1987 budget request for second repository activities is $78.7 million compared to the FY 1986 budget appropriation of $35.5 million. The increase is principally to fund preparation for on-site area-phase work which is scheduled to begin in FY 1988 and take approximately three-to-five years. The FY 1988 estimate for second repository activities is $74.2 million and the FY 1989 estimate is $71.5 million.

The major milestones leading to the site recommendation for the second repository are as follows:

Milestones	Calendar Year
o Issue final Region-to-Area Screening Methodology	April 1985
o Issue final regional characterization reports	September 1985
o Issue draft Area Recommendation Report	January 1986
o Issue final Area Recommendation Report	Summer 1986
o Identify Potentially Acceptable Sites	Summer 1986
o Issue final Area Characterization Plan and initiate crystalline rock area phase field investigations	November 1987
o Nominate and recommend sites to President for characterization	1993
o Recommend second repository site to Congress	1999

Monitored Retrievable Storage

The NWPA (Section 141) directs DOE to complete a study of the need for and feasibility of an MRS, and to submit to the Congress a proposal for the construction of one or more MRS facililties. The NWPA specifies that the proposal include a program for siting, development, construction and operation of an MRS facility; site specific designs and cost estimates for the construction of such a facility, should Congress approve its construction; a plan for funding the construction and operation of such a facility; and a plan for integrating such a facility into the overall Federal waste management system.

In spring of 1985, DOE completed its analysis of the need for and feasibility of an MRS facility and announced our

conclusion that such a facility could serve as an integral and important part of the overall waste disposal system. We identified a preferred site and two alternative sites, as required by the NWPA. The preferred site is the site of the cancelled Clinch River Breeder Reactor in Oak Ridge, Tennessee; and the two alternate sites are also in Tennessee -- one on the DOE Oak Ridge Reservation and the other near Hartsville. In addition, we completed the need and feasibility studies verifying our tentative conclusions.

Over the last nine months, we have worked closely with Tennessee in our development of the proposal to Congress. This interaction has principally been through Tennessee Governor Alexander's Safe Growth Council. To support their review of the proposal, we provided a grant of $1.4 million. The State in turn provided $100,000 each to the Clinch River MRS Task Force and the Hartsville Area Study Group to study the MRS proposal.

The Clinch River MRS Task Force completed their review in October 1985 and issued a report entitled "Recommendations on the Proposed Monitored Retrievable Storage Facility." In their report, the Task Force concluded that an MRS could be safely constructed and operated. In addition, Task Force members from the City of Oak Ridge and from Roane County passed resolutions stating that an MRS facility would be acceptable if certain conditions were met. In our proposal to Congress, which I will

discuss in more detail in a moment, we have attempted to meet those conditions.

In mid-December 1985, and as required by the NWPA, we submitted to the Nuclear Regulatory Commission (NRC) and to the Environmental Protection Agency (EPA) review copies of the Proposal to Congress, the Environmental Assessment on the MRS and an MRS Program Plan. At the same time, we provided copies to the State of Tennessee.

On January 21, 1986, Governor Alexander met with the Secretary of Energy and me to present the State's position on our proposal to construct an MRS at the Clinch River site. We are disappointed that the Governor does not share our view of the need for and value of an MRS. We are pleased that he, like the Clinch River MRS Task Force, shares our view that such a facility could be constructed and operated safely and is not a substitute for a permanent repository.

I would like to state for the record that in preparing the MRS Proposal to Congress, rarely have I seen such an excellent example of the results that positive Federal, State and local government cooperation can yield. I would hope that other State and local governments would take note of this mutually beneficial experience so that similarly close cooperation and participation might be realized elsewhere in the program.

We have met with and received comments on the MRS Proposal to Congress from both NRC and EPA. Neither the NRC nor EPA comments have required major changes to the proposal. A recent legal action has caused a postponement in submitting the proposal to Congress. The proposal will be accompanied by NRC comments

and EPA comments.

In our proposal, we will recommend that Congress:

- Approve the construction of an MRS facility at a site on the Clinch River in the Roane County portion of Oak Ridge, Tennessee;
- Limit the storage capacity at the MRS facility to 15,000 metric tons of spent fuel;
- Preclude waste acceptance by the MRS facility until a construction authorization for the first repository is received from the NRC;
- Direct DOE to implement measures responsive to the concerns and recommendations of the State of Tennessee and local governments; and,
- Direct DOE to implement the program plan accompanying the proposal.

The proposal contains extensive and unique provisions with regard to State and local involvement in the MRS program. The most innovative and far-reaching element contained in the proposal is the establishment of an MRS Steering Committee to provide a formal mechanism to obtain State and local input, including recommendations and evaluations regarding the design, construction, operation and, eventually, the decommissioning of the MRS facility. This Committee, composed of State and local government representatives of their own choosing, as well as DOE and industry representatives, would provide guidance, conduct evaluations, and, if necessary, recommend corrective actions with regard to the MRS facility. We are proposing that the Committee's involvement extend to a number of areas --

environment, safety and health; transportation; public information; and financial matters.

In accordance with other provisions of the NWPA, should Congress approve proceeding with an MRS facility, we are committed to seeking immediately to enter into a formal Consultation and Cooperation Agreement with the State of Tennessee.

The FY 1987 budget request supports proceeding with activities that are critical to deployment of an MRS facility. With this in mind, the FY 1987 request for MRS activities is $46 million compared to the FY 1986 budget appropriation of $3 million. These funds would be used primarily for site data collection and analysis, final design of the facility itself, regulatory compliance studies and State liaison activities. The schedule for construction of the MRS allows ten years from the time Congress approves our proceeding, to the start up of operations. The FY 1988 estimate is $50 million and the FY 1989 estimate is $53 million.

Nuclear Waste Fund

In April 1983, DOE adopted a fee of one mill (one-tenth of a cent) per kilowatt hour charged to utilities for all nuclear-generated electricity beginning April 7, 1983, as specified in the NWPA. Revenues collected from the on-going fee by DOE through December 31, 1985, total approximately $880 million.

In addition to spent fuel generated since April 7, 1983, spent fuel or high-level waste generated prior to that date is subject to a fee equivalent to an average charge of one mill per kilowatt hour. Utilities had until June 1985 to decide on one of

three payment options. Those who chose to pay in one lump sum by June 1985, to save interest charges, made payments totalling more than $1.4 billion. This represents more than half of the one-time fee liability of $2.3 billion for civilian nuclear waste in existence prior to April 7, 1983. Following receipt of these monies, DOE reimbursed the U.S. Treasury approximately $265 million, the total amount owed on the appropriated debt transferred to the Nuclear Waste Fund upon enactment of the NWPA.

In April 1985, the President accepted DOE's recommendation to dispose of defense waste in a commercial repository. The Federal Government, therefore, will pay an equivalent fee to that paid by utilities. This use of the repository will generate additional revenue for the Fund. The amount of the additional revenue is presently being determined and, therefore, is not included in our revenue estimates. We are in the final stages of discussions with DOE's Office of Defense Programs to determine an equitable cost-sharing methodology.

The revenue projections based on the one mill per kilowatt hour fee are shown in Table 3.

TABLE 3

NUCLEAR WASTE FUND REVENUE PROJECTIONS
($ in millions)

FY 1983 (actual)	$ 73.6
FY 1984 (actual)	329.5
FY 1985 (actual):	
-One mil/KWh	367.3
-One-time fee	1,427.4
-Interest Earned	38.4
FY 1986	
-One mil/KWh	378.6 a/
-One-time fee	2.3
-Interest Earned	118.0 b/
FY 1987	
-One mil/KWh	420.5 a/
-One-time fee	2.5
-Interest Earned	115.0 b/
FY 1988	
-One mil/KWh	474.5 a/
-One-time fee	17.2
-Interest Earned	105.0 b/
FY 1989	
-One mil/KWh	508.6 a/
-One-time fee	17.5
-Interest Earned	99.0 b/

a/ Based on projected gross nuclear electricity generation reduced by 5% to approximate net nuclear electricity generation as a result of the recent Wisconsin court decision. (Wisconsin Electric Power Company, et al vs. Hodel, 83-1066,84-8571 (decided December 6, 1985)). At the time of this budget submission, net nuclear electricity generation projections were not available.

b/ Based on average yield of Treasury security portfolio.

Transportation and Systems Integration

The FY 1987 budget request for activities associated with Transportation and Systems Integration is $33.4 million. The FY 1988 estimate is $33.8 million; and the FY 1989 estimate is $31.0 million.

The funding request for FY 1987 provides for development of adequate transportation and integrated systems for the shipping and management of nuclear waste among the various components of the disposal system.

The FY 1987 major activities include funding for the private sector to design, fabricate and test prototype casks for truck, rail and barge transport based on competitive procurements. Work will be continued to support institutional programs, environmental and economic analysis and technology development, data systems and testing and engineering development and systems integration.

The FY 1988 and FY 1989 estimates of $33.8 million and $31.0 million, respectively, would fund the continuation of these efforts.

Program Management and Support

The FY 1987 budget request for program management and technical support is $69.5 million. The FY 1988 estimate is $72.7 million; and the FY 1989 estimate is $72.2 million.

The FY 1987 funding level of $69.5 million provides technical support for waste management activities including (a) technical support integration, (b) development of standard materials characterization methods by the Material Characterization Center, and (c) supporting studies including fund management activities.

This funding level provides for a sustained staffing level from FY 1986 to FY 1987 of 292 full-time equivalent positions at headquarters and in the Operations Offices for fund management, site investigation, technology development and institutional liaison associated with the technical management of the repository, MRS (if approved), supporting programs and the management of the Nuclear Waste Fund.

The FY 1988 and FY 1989 estimates of $72.7 million and $72.2 million, respectively, will provide for program management and technical support associated with site characterization activities at three candidate repository sites, intensified siting efforts in the second repository program, a vigorous MRS program and increasing efforts in transportation systems development. Major emphasis will continue on developing an integrated cost-effective waste disposal system providing full protection of public health and safety and the environment.

CIVILIAN RADIOACTIVE WASTE R&D PROGRAM

Development and demonstration activities under the Civilian Radioactive Waste R&D Program are funded from the General Fund rather than funds collected from the utilties and deposited into the Nuclear Waste Fund.

The FY 1987 budget request for the Civilian Radioactive Waste R&D activities is $6.5 million compared to $16.0 million in FY 1986.

I would like to briefly discuss the strategy and highlight the activities which we plan to undertake in FY 1987.

Strategy

DOE's Civilian Radioactive Waste R&D program efforts are to utilize all means directed or available through the Act or other authority to encourage and expedite the availability of licensed new at-reactor storage technologies. No funds are requested for research and development concerning alternative means and technologies for the permanent disposal of high-level radioactive wastes, including the subseabed disposal concept. Activities to implement Section 222 -- alternative means of disposal -- are not proposed after FY 1986.

Spent Fuel Storage R&D

DOE's spent fuel storage development program is intended to encourage and expedite the most efficient use of existing storage facilities and the addition of new, licensed capacity in a timely fashion. The FY 1987 budget request to support these activities is $6.3 million compared to $8.5 in FY 1986.

Activities in FY 1987 will include continued dry storage cask testing as part of a cooperative agreement with Virginia Power; completion of preliminary tests and analyses on a transportable cask as part of a cooperative agreement with Carolina Power and Light; and initiation of rod consolidation demonstrations of spent fuel as part of a cooperative agreement with Northeast Utilities Services Company. In addition, we plan to continue cooperative activities in information exchange regarding spent fuel storage and disposal with non-nuclear weapon states and to continue to participate in international activities with the International Atomic Energy Agency, the Nuclear Energy Agency and the Federal Republic of Germany.

We do not plan to continue investigations into alternative disposal concepts, including subseabed disposal, nor generic methods and support studies beyond those international information exchanges and international involvement discussed under spent fuel storage development.

Program Direction

The FY 1987 budget request for program direction is $.2 million. At this level, three full-time equivalents would be funded to manage the Civilian Radioactive Waste R&D programs. Included are administrative and technical personnel who manage a broad range of activities such as: research, development, demonstration, industrial involvement and international programs.

In summary, Mr. Chairman, the FY 1987 budget request for spending authority under the Nuclear Waste Fund and for appropriations under the Civilian Radioactive Waste R&D budget are designed to carry out an integrated waste managment program in an efficient and effective manner and to achieve the 1998 mandate of the Nuclear Waste Policy Act, that is, to have in place a comprehensive and functional waste disposal system to begin receiving spent fuel.

This concludes my written testimony.

##########

U.S. Department of Energy
Assistant Secretary for
Congressional, Intergovernmental
and Public Affairs
Office of Public Affairs
Washington, D.C. 20585
202/252-5644

BIOGRAPHY

BEN C. RUSCHE

Ben C. Rusche is Director of the Office of Civilian Radioactive Waste Management, U.S. Department of Energy (DOE). This is a new position, and carries with it the responsibility for dealing with the nation's nuclear waste problems as mandated by the Nuclear Waste Policy Act of 1982.

Before coming to DOE, Mr. Rusche was serving as President of Management and Technical Resources, Inc., and also served as a consultant to Secretary of Energy Donald Paul Hodel. He was Vice President of Management Analysis Company from 1982 to 1984; a member of the Nuclear Regulatory Commission Task Group of the President's Private Sector Survey on Cost Control in 1982; and Special Assistant for Policy and Programs for Energy Secretary James B. Edwards, 1981-82.

He was Director of the South Carolina Energy Research Institute from 1978 until joining DOE in 1981, and while on leave of absence from that post served as Director of Waste Management, Three Mile Island Recovery Operations, for General Public Utilities Corporation, overseeing a major portion of that recovery effort.

From 1977 to 1978, Mr. Rusche was Director of Health and Safety for E.I. DuPont de Nemours & Co. From 1975 to 1977, he served as Director, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (NRC). He held various management positions at the Savannah River Laboratory from 1960 to 1975, was Senior Nuclear Engineer at Lockheed Aircraft Corporation from 1958 to 1960, and served as Nuclear Physicist at the Savannah River Plant from 1953 to 1958.

In 1953, Mr. Rusche received a B.S. degree in physics from the Tennessee Polytechnic University and did graduate work in reactor engineering at the Georgia Institute of Technology.

Mr. Rusche received the NRC Award of the Year for Outstanding Management Ability in 1976. His current and past organizational memberships include the American Association for the Advancement of Science, Kappa Mu Epsilon, Board of Trustees and the Executive Committee of Furman University, and Vice President of the Association of Governors' Board of Universities and Colleges. A prolific writer, Mr. Rusche has authored and co-authored numerous articles on nuclear energy.

Born in Yazoo City, Mississippi, Mr. Rusche is married and has three children.

June 1984

WEDNESDAY, MARCH 12, 1986.

URANIUM ENRICHMENT PROGRAM

WITNESSES

JAMES W. VAUGHAN, JR., ACTING ASSISTANT SECRETARY FOR NUCLEAR ENERGY

JOHN R. LONGENECKER, DEPUTY ASSISTANT SECRETARY FOR URANIUM ENRICHMENT

Mr. BEVILL. Good morning. The committee will come to order. Mr. Secretary, we're pleased to have you back, and, Mr. Longenecker, we're mighty pleased to have you with us. The two of you may proceed as you wish.

Mr. VAUGHAN. Mr. Chairman, Mr. Myers, it is a pleasure for us to be here to summarize the Department's Fiscal Year 1987 budget request for uranium enrichment activities. And, as customary, I provided a more detailed statement which we will like to have entered in the record.

Mr. BEVILL. All right. It will be admitted.

OPENING STATEMENT OF JAMES W. VAUGHAN, JR.

Mr. VAUGHAN. Our Fiscal Year 1987 budget request for the Uranium Enrichment program is approximately $1.05 billion in budget authority, which will be fully offset by $1.29 billion in projected revenues. In addition, DOE proposes to return $235 million to the Treasury as a part of the repayment of prior Government investment in the uranium enrichment enterprise. Additional detail regarding the distribution of these funds among the major elements of the program is tabulated in my written statement.

Our primary objective in the uranium enrichment enterprise is to retain a competitive, financially healthy uranium enrichment capability in the United States for the long-term consistent with the Atomic Energy Act, other legal requirements, and the best interests of the nation.

We appreciate very much this subcommittee's keen interest, encouragement, and constructive legislative guidance over the past several years.

We have established seven major goals for the U.S. uranium enrichment enterprise, which were articulated in our strategy issued last June 1985. These include, first, to bring supply and demand of DOE-origin enriched uranium into balance; second, to offer reliable customer services; third, to offer competitive prices; fourth, to capture the uncommitted market consistent with financial interests; fifth, to minimize the cost of operating existing enrichment plants; sixth, to retain U.S. leadership in advanced technology and to deploy it as appropriate to meet our business objectives; and seventh, to adopt a more businesslike institutional structure.

We have made some important progress towards achieving these goals. And what I would like to do at this point, is have John Longenecker use some charts to briefly summarize these accomplishments, and then I'd like to return for a minute to the key issues facing us for the future.

Mr. BEVILL. Mr. Longenecker?

Mr. LONGENECKER. Mr. Chairman, what I'd like to focus on is how our competitive strategy has worked in the marketplace. We described for you two years ago, and again last year, the key problem that we faced, and that was a plummeting share of the world market. We were losing market share primarily because our price and terms were not competitive.

[Charts follow:]

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Uranium Enrichment Accomplishments

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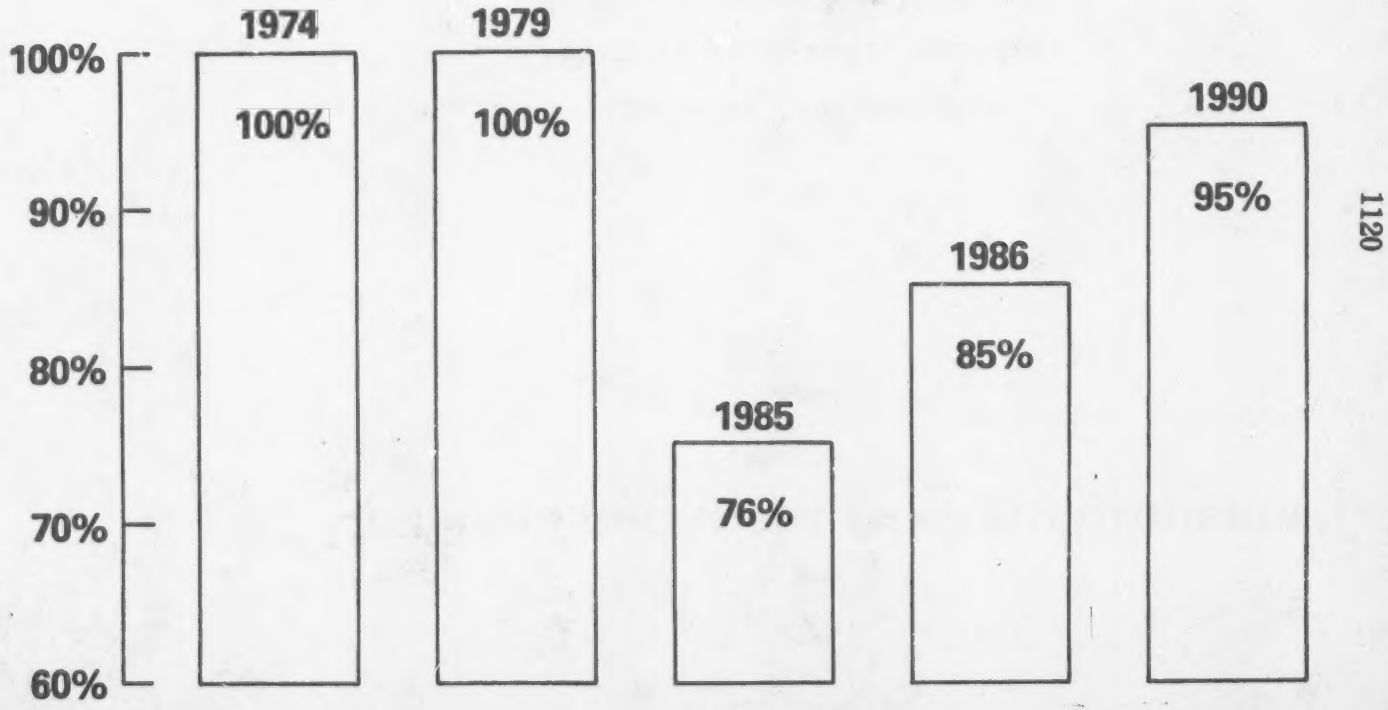
By

John R. Longenecker
Deputy Assistant Secretary
for Uranium Enrichment

March
1986

DOE Share of the Domestic Market



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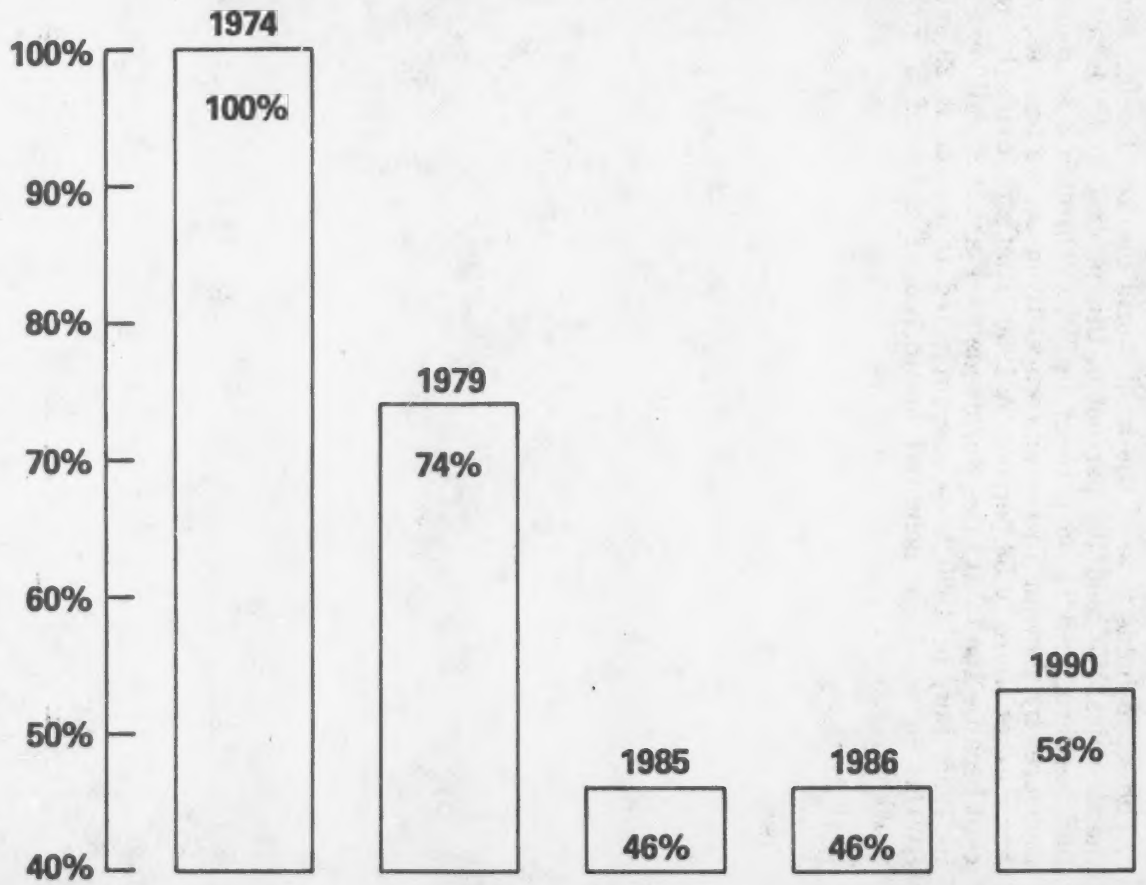
DOE Share of the Free World Market



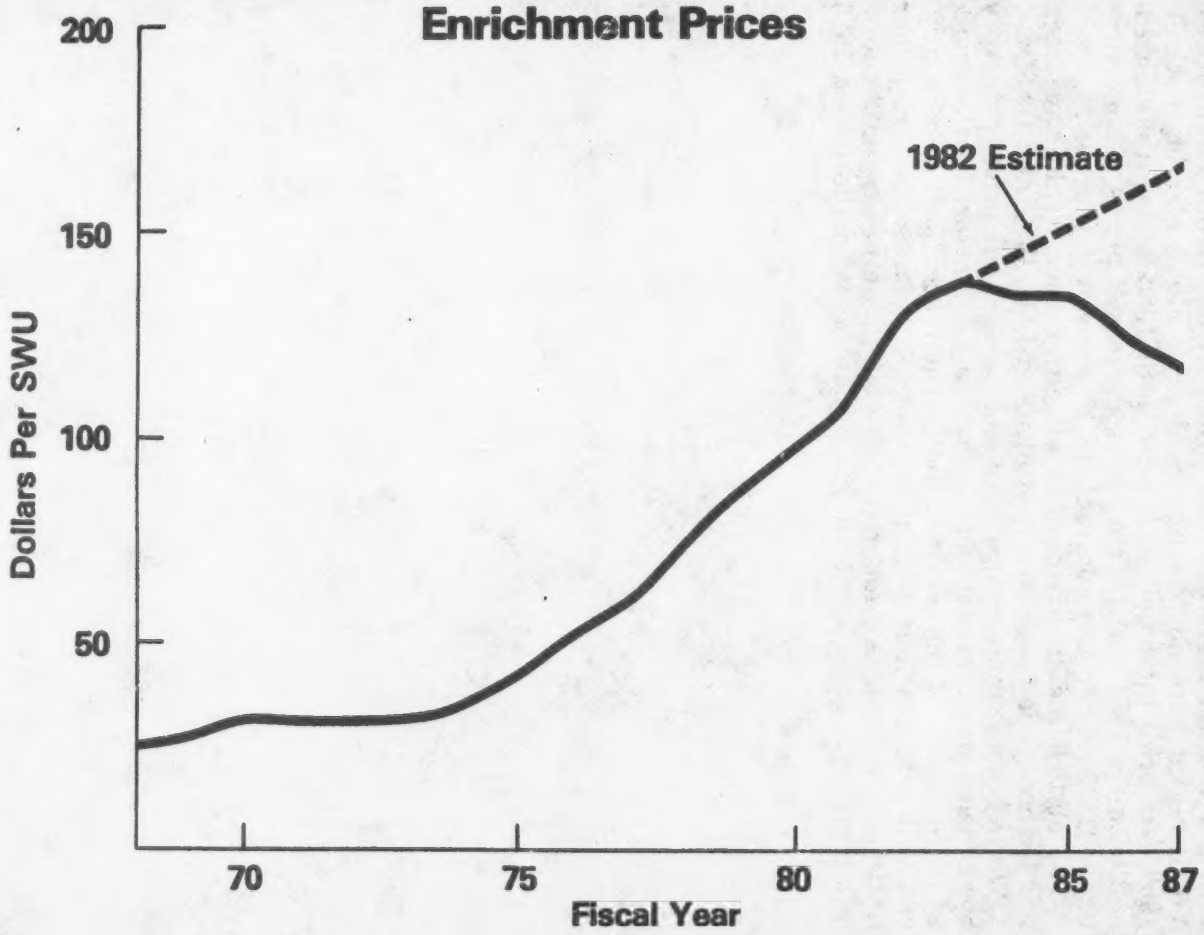
The same holds true of the total world market, foreign and domestic sales. We held 100 percent of this market in 1974, but that had been reduced to 46 percent in 1985. Through cost reduction measures by showing increased competitiveness, we have increased our market share to 53 percent by 1990. That's particularly significant because the total sales worldwide were about 22 million SWUs in 1985, but, in 1990 they are projected to be about 29 million SWUs. So we have achieved an increased share of a growing market.

This turnaround in our fortunes shown by a rather dramatic increase in market share has been primarily due to our lower prices. You'll notice here on our historical price curve starting back in 1969, our price increased each year until 1983, when it stabilized; and between 1984 and 1987 we have decreased prices to customers under Utilities Services contracts by 30 percent in real terms.

The dotted line shown here is what the price would have been had we not made program adjustments in 1984, 1985, and 1986.

We've become more competitive and lowered our prices primarily by reducing program costs and introducing a contract that responded more closely to the needs of the marketplace. Most importantly, you will note that our 1982 plan, that we described to you in our testimony in 1983, as compared to our 1986 plan has reduced cumulative program costs by about $14 billion between the period 1985 and 1995.

[Chart follows:]


Enrichment Prices
200
150
100
50
Dollars Per SWU
1982 Estimate
70
75
80
85
87
Fiscal Year

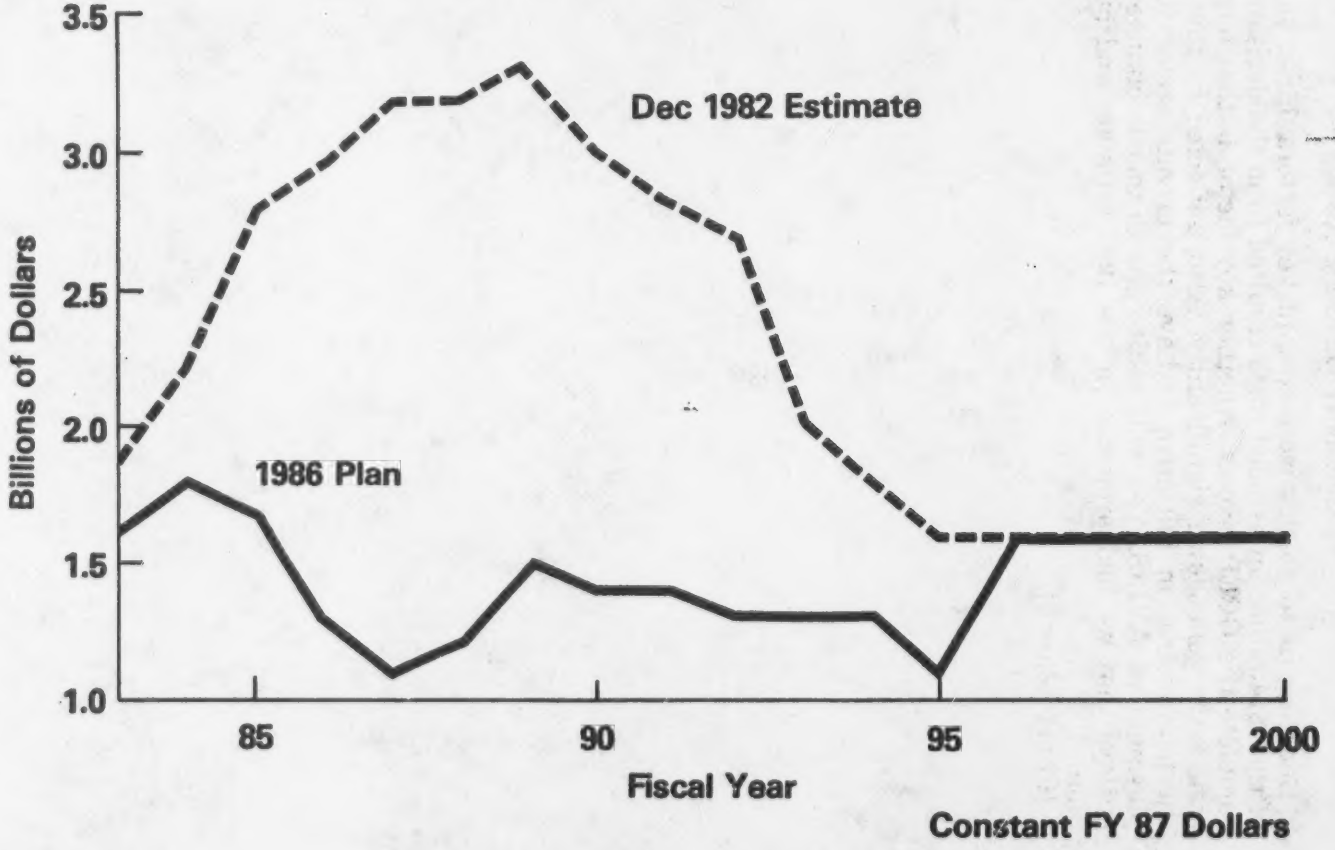
1124

ENRICHMENT PROGRAM COSTS

Enabling us to do this were several key factors. First, $5 billion of that $14 billion in avoided costs resulted from the decision not to complete the GCEP project. Another key factor is that our power costs have gone down significantly. Also, reflected in this line is the administration initiative to have the private sector fund deployment of AVLIS. You will notice the dramatic change in the outlays that we had projected in the 1982 estimate and our 1986 plan.

[Chart follows:]

Program Costs



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Now, a key factor in our competitiveness today is a reduction in the cost of production from the gaseous diffusion plants. We're very proud of the progress that our gaseous diffusion team has made. As you'll notice, beginning in about 1983, when we attempted to become more competitive and to regain market share, we decreased the average cost of production from gaseous diffusion from about $90 a SWU to about $76 per SWU in 1987.

[Chart follows:]

Gaseous Diffusion Production Costs

(Excludes Unused Electrical Demand Charges)

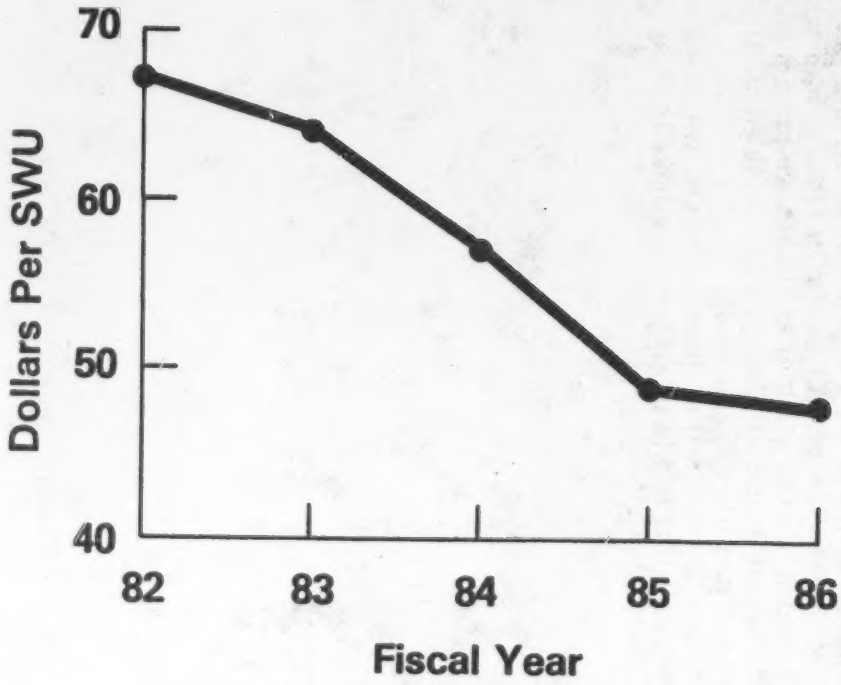
The largest portion of our budget annually is electrical power. Those costs have gone down as well. You'll notice that in 1982 we were paying close to $70 in power to produce one SWU. The energy component to produce one SWU from the gaseous diffusion plants was down in the range of $50 per SWU in 1986 and again in 1987.

Electricity prices nationwide, of course, have gone up slightly over the past few years. What this reflects is our shift, beginning in 1983, to the cheapest source of electrical power. Today most of our production is out of the Portsmouth plant, and that has our lowest cost of power. The cost of power in Ohio is half what it is in the TVA region. So the gradual shift that we have made to production at Portsmouth and at Paducah has enabled us to lower our unit energy costs rather dramatically.

At this point on the chart is where we stopped buying TVA power, and this is where all power is bought from EEI and OVEC.

[Chart follows:]

Declining Energy Costs to the GDP's



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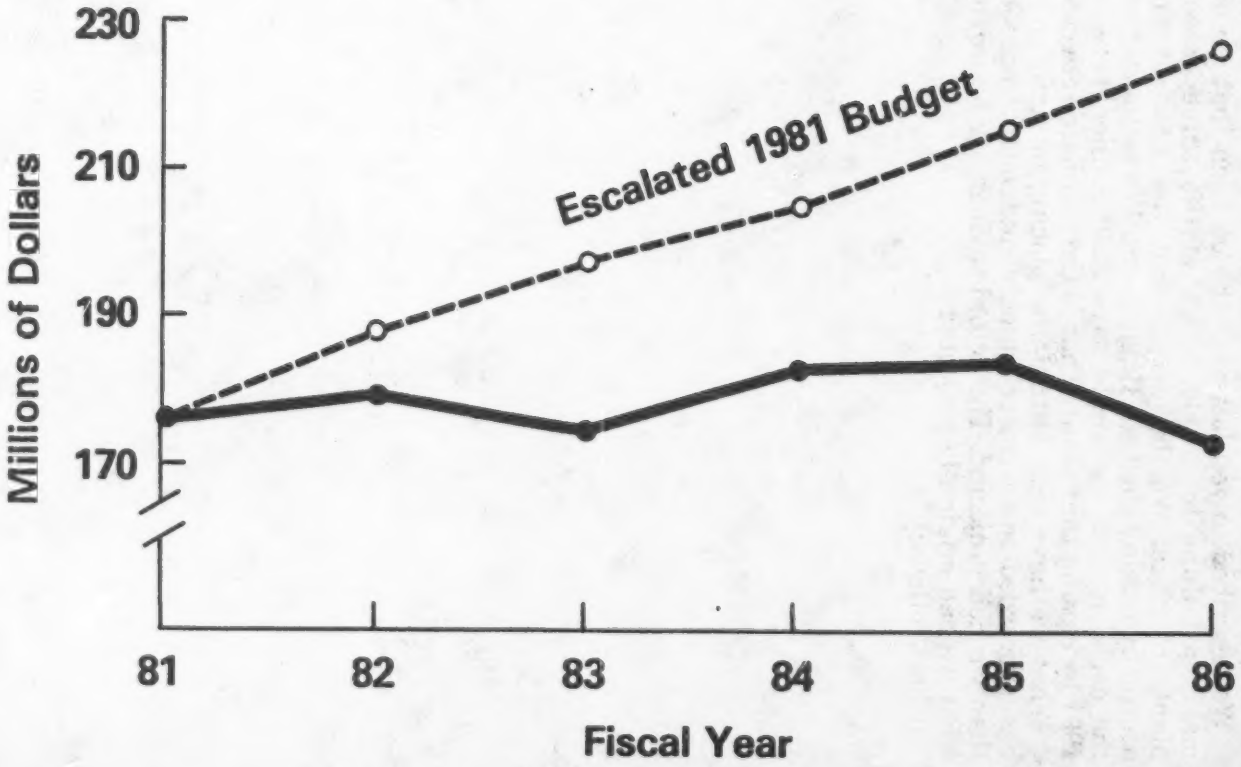
Operating Cost at the GDP's



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We described to you last year the decision that we were going to make last June to decide which of the three gaseous diffusion plants to close. We did decide that the greatest savings would accrue by closing the Oak Ridge plant. We estimated at the time of the decision that we would save $250 million between 1986 and 1991 by closing that plant. That is the estimate reflected here.

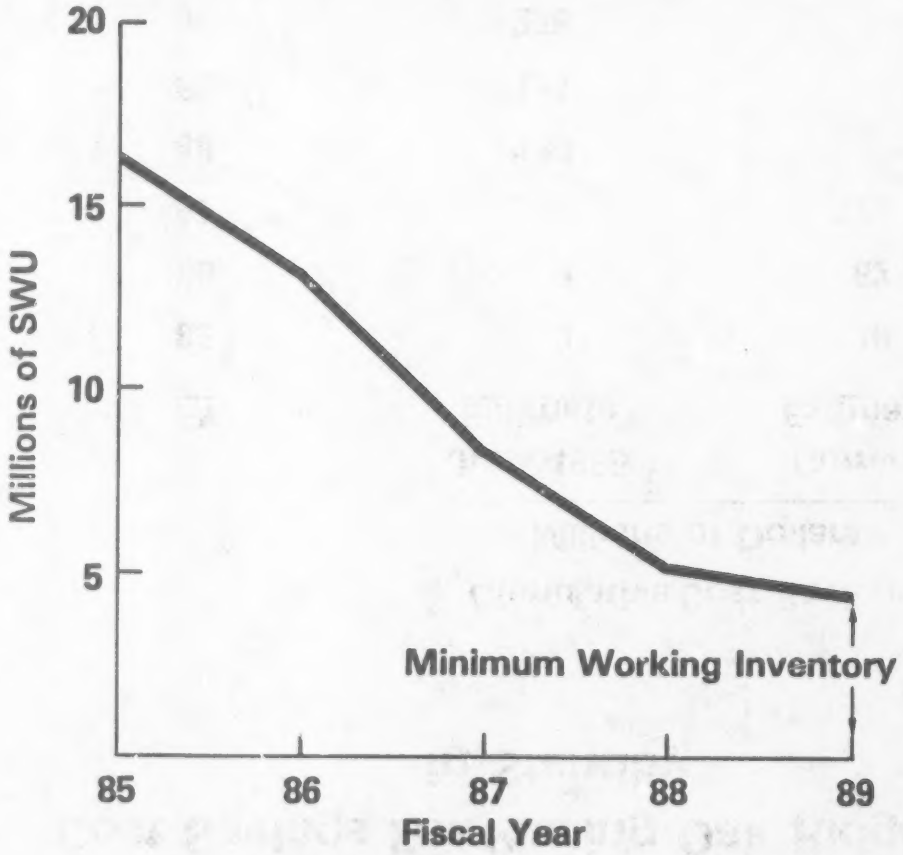
What we have seen is that the placing in standby of that plant has proceeded much more quickly and much more economically than we had projected. The actual savings are approximately twice what we had originally projected.

[Chart follows:]

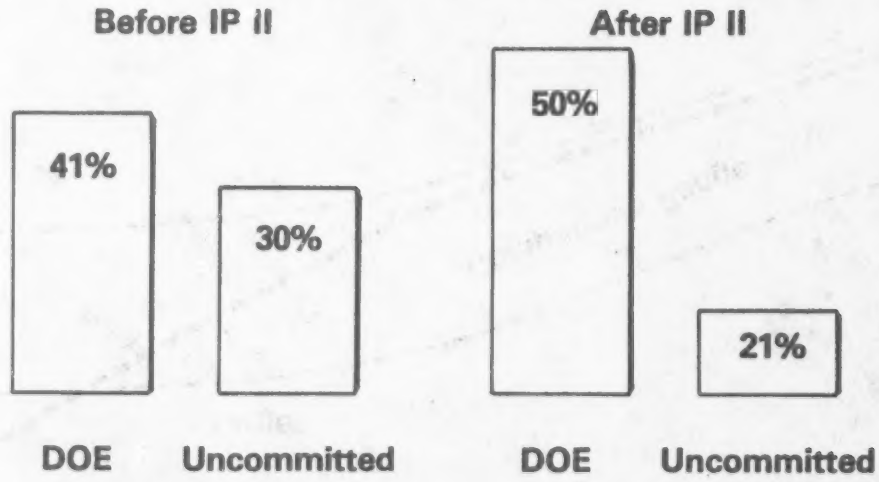
Cost Savings For Placing Oak Ridge GDP in Standby

FY	Cumulative Cost Savings Millions of Dollars	
	June 1985 Estimate	Current Estimate
85	0	10
86	9	62
87	64	125
88	130	
89	191	
90	236	
91	255	

Uranium Enrichment Inventory

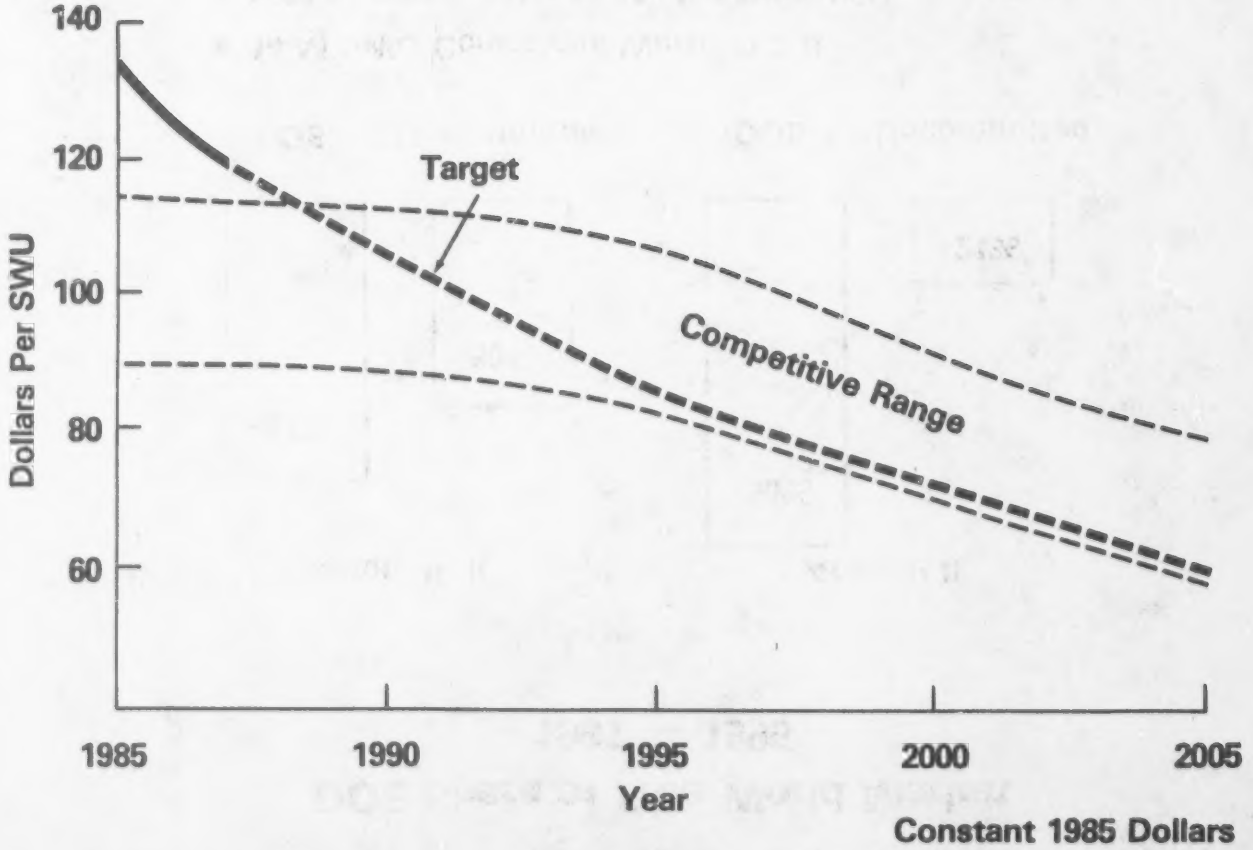


DOE Share of Free World Market
1991 — 1995



- 14 M SWU Committed Worth $1.2 B
- > 30 M SWU of World Market Remain Uncommitted (1991 — 1995)

Price Projections



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Shown here is our price chart. It demonstrates what we believe we will have to do in the future to assure that we can retain the market share that we have and compete for the uncommitted market share throughout the world. Shown here is the decline in our price that we have been able to achieve from Fiscal Year 1985, when we introduced the U.S. contract, through Fiscal Year 1987.

It's clear to us that we will need to continue to decrease our price in the future until we get into the competitive range, and then to foster deployment of AVLIS technology to assure that we can stay in the competitive range in the future. The cornerstone of our strategy is competitive pricing in the world marketplace.

The key to long-term competitiveness is the introduction of advanced technology. Our average price of gaseous diffusion has been decreasing, but we are now almost at a minimum point on that curve. We have done almost all that we can to achieve significant cost reductions in gaseous diffusion. We believe that by the late 1990's, we will need to have AVLIS deployed in the United States to remain competitive.

[Picture follows:]

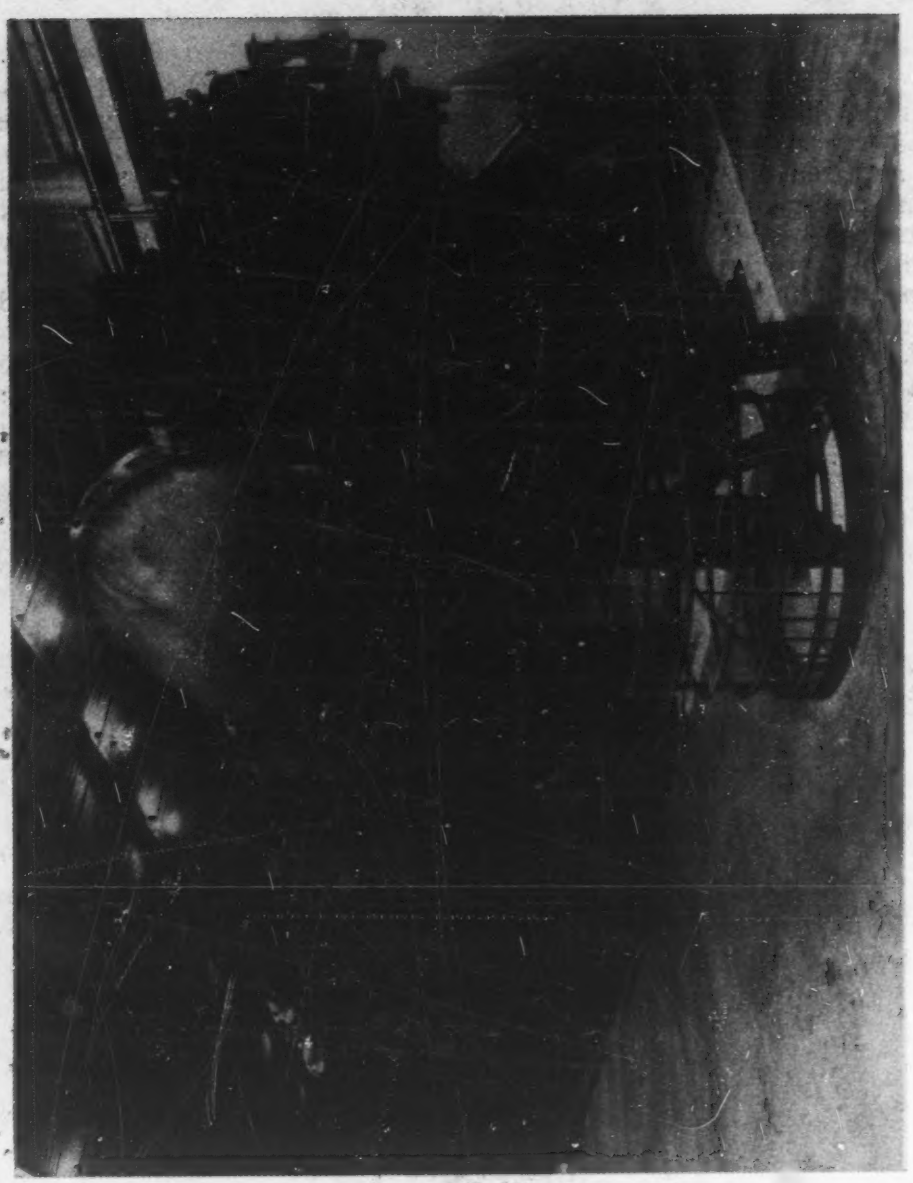
AVLIS Full-Scale Demonstration Facility

AVLIS PROGRAM

I'd like to review for you just briefly the status of the AVLIS program. Shown here is the full scale demonstration facility at the Lawrence Livermore National Laboratory. Now, our AVLIS team, comprised of Martin Marietta and Lawrence Livermore National Laboratory, has designed and constructed this facility over the past several years. This will be the location of most of the activity during this fiscal year and next fiscal year, when we will be working on the problems identified by the Process Evaluation Board and moving the technology towards deployment.

Just briefly, shown here in this cutaway is the outline of the AVLIS demonstration facility. This is the large separator, these are dye lasers and optics corridors, and these are pump lasers. You'll notice here the full scale separator is fabricated and in place and is undergoing initial checkout for operation.

[Picture follows:]



You'll notice that in developing this very complex technology we are reasonably far along. We are certainly not technology limited. The challenge we face is to retain the roughly five year lead that we have on the rest of the world, and to match the development and deployment of this technology to fit the marketplace in the next decade.

Thank you.

FUTURE PERSPECTIVE

Mr. VAUGHAN. I think, gentlemen, as you can see from the charts Mr. Longenecker presented, we've made some excellent progress in becoming more cost competitive, improving the operation of the GDPs, and in continuing the development of what we think is the world's most advanced enrichment technology.

However, the key factor that we face this year, and that we'd like to focus on this morning, is that there is much more to be done and the next two years are very critical for the enrichment enterprise. We do believe the prospects continue to improve to help us have a bright future for that enterprise in the United States.

One of the key actions we've recently initiated is the proposed modification of the uranium enrichment services criteria. As you know, we published a proposed rulemaking in the Federal Register at the end of January 1986. These proposed criteria address first, the items that were questioned in the miners' lawsuit; second, other aspects of the enterprise, including the flexibility for future competitive actions; and third, a reiteration of the Administration's position opposing restrictions on the enrichment of foreign natural uranium. We hope to be able to complete this rulemaking process by the end of the summer.

A new initiative which is now under review is an effort to transfer future development and ultimate deployment of the AVLIS technology to the private sector. I would emphasize the words, under review, because we do not have a definitive plan and study in place. It is an initiative that is being initiated, if I can make a play on words there, and it is part of a general evaluation of areas in which we believe the private sector can beneficially be involved in the enterprise.

There may be other areas that we can combine it with that would help make the total picture more attractive to the private sector, but as a minimum it is hoped that the private sector will be interested in deploying the AVLIS technology. Because, as Mr. Longenecker has described, we think this advanced method holds significant technical and economic potential for the United States, it therefore should provide the type of challenge which the private sector has, in many other areas in this country, demonstrated its capability to meet.

We do plan later this year to initiate an industrial access program to allow qualified U.S. firms to become familiar with the AVLIS technology as a first step in assuring that there is an industrial base to deploy the technology in the future.

Once again I'd like to emphasize that we appreciate the encouragement and support of this subcommittee. We think together we've made a significant amount of progress in returning the U.S.

enrichment enterprise to a more healthy financial state. We plan to continue these efforts along with the new initiatives that we previously mentioned during fiscal year 1987.

This completes my summary remarks, and Mr. Longenecker and I would be very pleased to respond to your questions.

[Statement of Mr. Vaughan is included at the end of the hearing record.]

INVENTORY

Mr. BEVILL. Mr. Longenecker, though the reductions in cost are impressive, I noticed that you never did mention what's happening to the inventory.

Are you reducing the inventory?

Mr. LONGENECKER. Yes, sir, we are.

Mr. BEVILL. You're selling the inventory and showing that as a reduction in budget aren't you?

Mr. LONGENECKER. The operating costs, particularly the cost for electricity, over the next three years will be reduced by the sale of inventory at approximately 4 million SWUs per year. So we are selling inventory, deliberately keeping our production low, because over the next few years our fixed costs are about 55 percent of our budget.

TVA's demand charge is 45 percent of our outlays, and closeout of the centrifuge programs is about 10 percent more. So under very severe financial constraints, the only means by which we can make those payments and the payments to Treasury, which are reflected in our 1986 and 1987 budget, is through the sale of our preproduced inventory.

Mr. BEVILL. Yes, I understand. But how long will your inventory last now at the rate you're selling it?

Mr. LONGENECKER. At the rate projected here, we will be at a minimum working inventory of 120 days of advanced customer requirements by 1988.

Mr. BEVILL. Your inventory will last about two more years, so you're selling off your insurance—your inventory which is simply reducing the budget in the short term. In a couple of years, what's going to happen after you have sold off your inventory and you don't have it to reduce your cost, what's it going to do?

Mr. LONGENECKER. Well, in the timeframe post-1988, the TVA demand charge begins to decrease. And in that time frame the centrifuge program will also have been closed out. So that the pressure on our outlays will not be nearly as severe as it is today.

Mr. BEVILL. Actually, the point I'm making is you haven't done much to actually reduce your costs, have you, other than sell the inventory?

Mr. LONGENECKER. Yes, we have.

Mr. BEVILL. What have you done to reduce costs besides selling the inventory?

Mr. LONGENECKER. We have decreased the cost of operating the gaseous diffusion plants, and we have decreased dramatically the unit cost of power.

Mr. BEVILL. How did you do that?

Mr. LONGENECKER. Primarily by buying power at the cheapest source. Our electricity rate in Ohio, at OVEC, is about 18 mills per kilowatt hour. The rate under our TVA contract is about 36 mills. That's the primary reason that we put the Oak Ridge plant into standby and moved most of our production to Portsmouth.

So the unit cost for each SWU produced has declined dramatically over the past three years.

Mr. BEVILL. But it hasn't declined the amount you're showing on those charts, because what you're showing on those charts includes the reduction of the inventory, right?

Mr. LONGENECKER. It does indeed.

Mr. BEVILL. Now, if you had not been selling the inventory off, how would that line look?

Mr. LONGENECKER. If we were not selling our inventory, if we were actually matching this year production with sales, our outlays would probably be several hundred million dollars higher. So rather than $1 billion, I would estimate that it would be about $1.3 billion.

Mr. BEVILL. So the line wouldn't be dropping that way. It would be more of a straight line or it would drop some, but not much.

Mr. LONGENECKER. It would have dropped significantly from 1984. In 1984 we had outlays of about $1.9 billion. And of that, about $500 million was for construction of GCEP. That is another significant cost item that has been eliminated from our budget request.

Mr. BEVILL. Could you take a pencil and roughly draft just what would have happened there disregarding the inventory?

PROGRAM COSTS

Mr. LONGENECKER. I have an outlay chart.

[Chart follows:]

ENRICHMENT MARKET

As you recall, in 1979 we had 100 percent of the domestic market. But because of our noncompetitiveness, by 1985 our market share had been reduced to 76 percent. We're pleased that after having announced our new competitive strategy in 1984, the decisions of June 1985, the lower prices that we have offered for the last three fiscal years and after some innovative marketing initiatives, we've been able to increase by 1990 our share of the domestic market to 95 percent.

[Chart follows:]

Another key accomplishment of the gaseous diffusion team has been to hold the line on inflation and non-power operating costs. The second largest component of our budget is the cost required to operate and maintain the gaseous diffusion plants.

Shown here is the escalated cost of our 1981 budget for operating three gaseous diffusion plants. Through some very innovative means of managing the plants, and through the discovery of some more flexible ways of operating them, we have been able to hold the line on inflation and essentially hold our operating costs constant from 1981 to 1986. At the same time, we were upgrading the plants to take care of increased environmental requirements and increased safeguard and security requirements. Some tremendous accomplishments were made by our gaseous diffusion team, and those actions are the key to the reductions in cost and price that we have seen in the last three years.

[Chart follows:]

INVENTORY

Another key means by which we are going to keep our program outlays down over the next few years is by the sale of preproduced enriched uranium inventories. We have today about 17 million SWUs of enriched uranium in our inventory. Over the next two fiscal years we will be producing about 7.5 million SWUs each year while we sell about 11.5. We'll be drawing down each year our inventory until we reach what we call a minimum working inventory in 1988. That minimum working inventory represents 120 days of advance customer requirements that we keep for operational and security considerations.

But by selling this preproduced inventory, we will keep our outlays low and enable competitive pricing, at the same time, we pay the TVA demand charge for power not taken which is $450 million in fiscal 1987.

[Chart follows:]

MARKET SHARE

To illustrate one of the initiatives by which we have increased our market, I'd like to review for you the results of the recent incentive price offer. In December 1985, we offered customers under the Utilities Services contracts a discounted price for the top 30 percent of their requirements for the period 1991 through 1995. You will note that before the incentive price offer, 41 percent of the world market was firmly committed to DOE, and 30 percent of the world market was uncommitted to any supplier.

As a result of that initiative, we have increased our firm market share by 9 percent and decreased the uncommitted market share by a like amount. That represents an additional sale of 14 million SWUs, worth about $1.2 billion, in the period 1991 through 1995.

There is another very significant point, however, that I'd like to make from this chart. You will note that 21 percent of the world market in that time frame is still uncommitted. That represents over 30 million SWUs, and that portion of the market will go to the supplier with the most competitive price and terms.

[Charts follow:]

Here is the first completed corridor of pump lasers, and this is one complete corridor of the dye lasers and optics.

[Pictures follow:]

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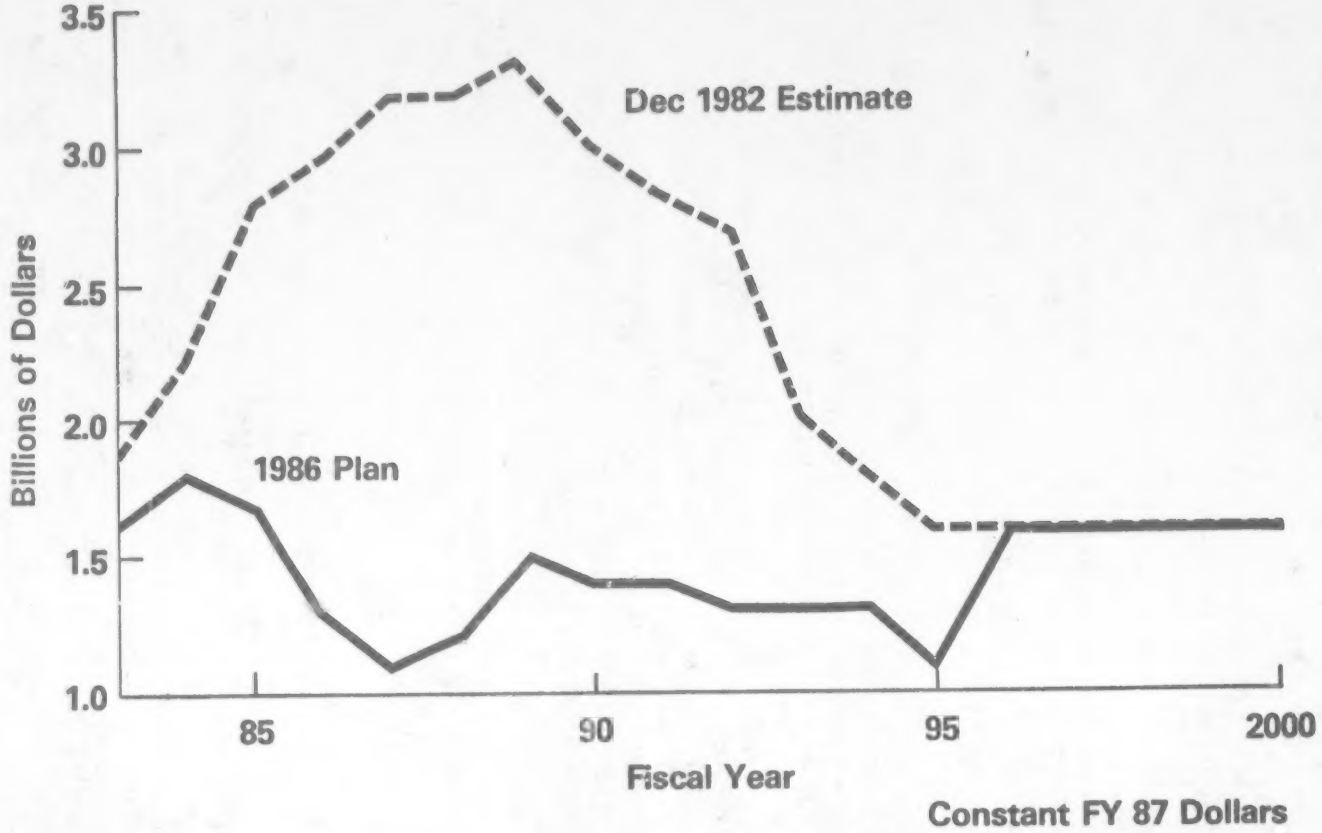
Program Costs



Mr. BEVILL. Well, let's put it up there and see just where that line would be if you didn't count the inventory. I want to see how much it reduces the cost of production.

Mr. LONGENECKER. Mr. Chairman, your postulate is that we would retain the inventory at 17 million SWUs?

Mr. BEVILL. Yes.

Mr. LONGENECKER. This line shown here on the 1986 plan, were we not to sell from inventory, would be in this time frame here, where we are selling the inventory, would essentially be flat. So this reduction in net outlays represents almost directly the sale of inventory.

Mr. MYERS. Would you yield on that?

Mr. BEVILL. Yes.

INVENTORY

Mr. MYERS. What are you getting for that inventory; what price are you getting per SWU; and what did it cost to produce that SWU? I think that would answer the question here.

Mr. BEVILL. Yes.

Mr. LONGENECKER. Well, the average production cost of our inventory, Mr. Myers, is about $85 per SWU.

Mr. MYERS. And what are you selling it for today?

Mr. LONGENECKER. $125 per SWU.

Mr. MYERS. Well, how can that be?

Mr. VAUGHAN. There are other costs which have to be recovered in addition to production costs.

Mr. MYERS. No, I mean, I thought you would just recover the cost of that plus a small profit to return to the Government. You're charging $125, and how can you meet world competition at that price when they're selling for $90 everyplace else, aren't they, or about that?

Mr. VAUGHAN. I think you have to talk about the cost of producing SWUs as compared to the price of SWUs.

Mr. MYERS. Pardon me for using your time, but I think that's the question right there; what it costs to produce it and what we're selling it for.

Mr. LONGENECKER. Each year our selling price is comprised of the cost of gaseous diffusion operations, cost of research and development, as well as other costs. And so, the difference between the $125 price and the price of our inventory is the allocation of those other costs. So under cost recovery, we must recover those as well.

Mr. MYERS. In other words, you haven't got anything in those SWUs that's been in the inventory. You've been selling and keeping your payments going on the existing sales at the time, so there's no dollar investment in the SWU's as far as——

Mr. LONGENECKER. The inventory was produced before this fiscal year, and it is a sunk cost.

Mr. MYERS. It is a sunk cost.

Mr. LONGENECKER. Now, holding them under our cost recovery requirements does require us to impute interest on them each year. So there is a carrying cost of maintaining the inventory, which is an accounting cost, but not a real cash outlay on the enrichment budget.

Mr. MYERS. But $90 is what the cost—between all the costs that you've associated here, with the allocated research, the cost of the production of the SWUs, you've got $90 in them, and you're selling for $125.

Mr. LONGENECKER. That's direct production cost.

Mr. MYERS. What about those other things that you have to allocate to them, that you say you had to——

Mr. LONGENECKER. Well, allocated in that is R&D, as well as imputed interest, depreciation of existing facilities, and other indirect costs.

Mr. MYERS. What would that push it to?

Mr. LONGENECKER. Excuse me?

Mr. MYERS. What would that push it to, then?

Mr. LONGENECKER. Well, that is what comprises the $125 price.

Mr. MYERS. Well, since we're on that issue, if I may ask one more question, you have $90 in those SWUs in inventory. What does it cost you today to produce a SWU?

PRODUCTION COSTS

Mr. LONGENECKER. Our marginal cost at Portsmouth is about $35 per SWU. Our average production cost is about $70 per SWU, excluding charges for power not taken.

Mr. VAUGHAN. To answer Mr. Myers' question, we need to go to the base cost. You produce a certain number of SWUs with your fixed minimum cost of operating the plant. And then, as you get to that point, the more additional SWUs that you produce, the unit cost per SWU goes down. The cost to produce in any given year has to be the averaging or integration of those numbers.

Mr. MYERS. OK.

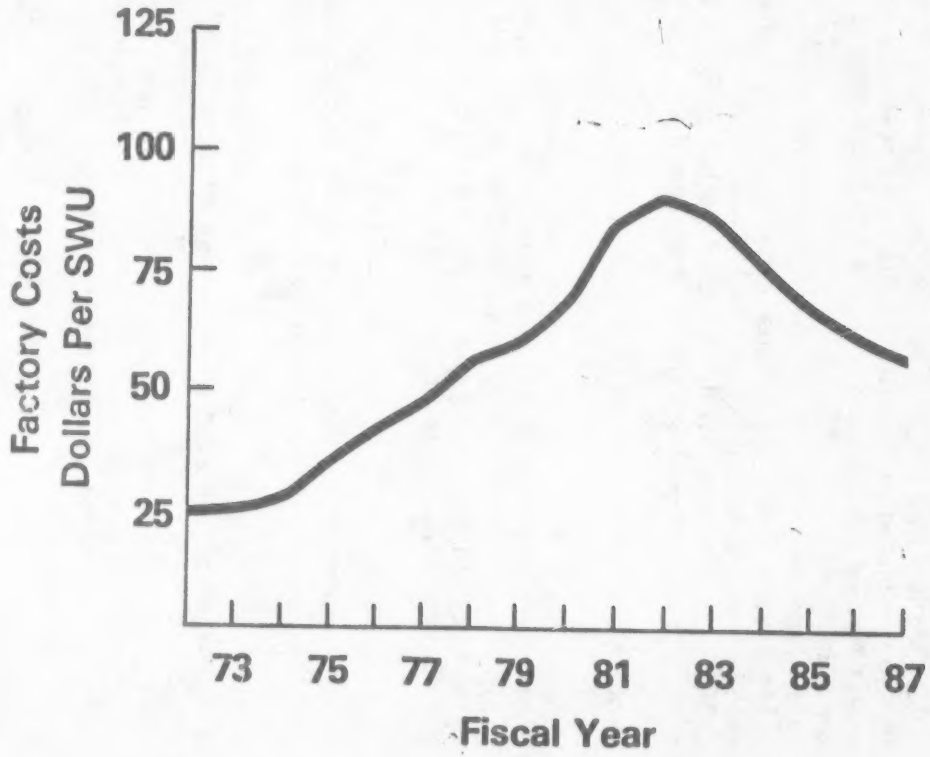
Mr. VAUGHAN. And so, there's not a single dollar number to produce a SWU. You've got a certain amount of fixed cost, and if you produce enough to spread those fixed costs, and then you make another 20 percent, the marginal cost to produce the extra is not as great.

Mr. MYERS. OK. Thank you, Tom. Sorry to take your time.

[Chart follows:]

Gaseous Diffusion Production Costs

(Excludes Unused Electrical Demand Charges)



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Mr. LONGENECKER. Mr. Myers, if I might answer your question from this chart. The average cost of production today, which is the composite of Portsmouth and Paducah, is about $70. The marginal cost at Portsmouth today is about $35. So that's for one additional SWU or one million additional SWUs from that plant.

Mr. MYERS. Well, what's the difference between marginal cost and total cost?

Mr. LONGENECKER. On a marginal cost basis you have——

Mr. MYERS. You see, you're comparing two different figures to two different plants. Give me the same figures to the different plants, the same costs. Why can't you do that?

Mr. LONGENECKER. Well, the marginal cost today at Portsmouth is about $35 per SWU.

Mr. MYERS. And what is it——

Mr. LONGENECKER. At Paducah it's about $45 per SWU.

Mr. MYERS. $10. Okay.

Mr. LONGENECKER. That's primarily due to the difference in the cost of power.

Mr. MYERS. Now, is the overhead the same at both plants?

Mr. LONGENECKER. Approximately. In very simple terms, the——

Mr. MYERS. I mean the other associated costs such as the—whatever percentage you give to operating costs—not operating costs. I'm talking about what you would charge back for the research, whatever percentage that is.

Mr. LONGENECKER. They are equally allocated.

Mr. MYERS. Okay.

Mr. LONGENECKER. To answer your question, we're selling inventory to be able to pay the TVA demand charge and to make payments to Treasury.

Mr. MYERS. Thank you, Tom.

Mr. VAUGHAN. What we've done, Mr. Chairman, is try to achieve the best balance we can against a known amount of revenues. The reduced production costs to make that balance over the next couple of years can be compensated by selling inventory up to a point where the TVA demand charges start to drop off, then we have more flexible funding for the increased production amounts so they more nearly balance annual sales.

TVA POWER

Mr. BEVILL. As I understand it, you don't use the TVA power now?

Mr. VAUGHAN. We do not use the TVA power.

Mr. BEVILL. Why did you quit using the TVA power?

Mr. VAUGHAN. The basic reason is it's too expensive. We can buy cheaper power from the other two suppliers who supply totally Portsmouth and half of the Paducah plant. These demand charges that we refer to—sometimes called capacity charges—are charges of about $450 million a year for power not taken.

Mr. BEVILL. That's where you guarantee a minimum.

Mr. VAUGHAN. That's where we, a number of years ago, projected a minimum purchase level.

Mr. BEVILL. Do you have to do that now?

Mr. VAUGHAN. We have to pay that up through 1991.

Mr. LONGENECKER. 1992.

Mr. VAUGHAN. 1992. The terms of the contract, of course, were based upon projections for the number of nuclear power plants which exceeded what the demand has been. We're allowed to shed the amount we take with eight years advance notice. We've been shedding as much as we could, and in 1988 and 1989 the demand charges start to drop, and then they will be totally gone by 1992.

Mr. BEVILL. Does that mean you're going to pay TVA now over $400 million from now until 1992 per year——

Mr. LONGENECKER. Until about 1992, Mr. Chairman. We'll pay them an additional $1.8 billion, it started at $450 million per year.

Mr. BEVILL. Do you mean that——

Mr. VAUGHAN. But in the latter years it's not that high.

Mr. BEVILL. You're paying $400 and some odd million now minimum because of the contract, is that right?

Mr. LONGENECKER. Yes, sir.

Mr. BEVILL. Mr. Longenecker?

Mr. LONGENECKER. Yes, sir.

Mr. BEVILL. All right. Now that you are no longer using TVA power, you still pay that $460 million, is that what it is?

Mr. LONGENECKER. $450 million.

Mr. BEVILL. $450 million. And then go out somewhere else and buy it cheaper than you can even if you were using that $450 million worth of power?

Mr. LONGENECKER. Yes, sir. Substantially less.

Mr. BEVILL. Well, that's a tremendous price difference, isn't it?

Mr. LONGENECKER. It is, indeed. As I mentioned earlier, the cost of TVA power is twice the cost of power in Ohio. So of $36 per megawatt hour, at TVA's rates, approximately $11 of that is the demand charge that we must pay whether we take any electricity or not. The energy portion, or that which derives from the fuel that they burn to generate the electricity, is $25. We can buy total power demand, plus energy, for $18 in Ohio and about $24 in Kentucky. And therefore, the decision was made to stop buying TVA power and to put the Oak Ridge gaseous diffusion plant in standby.

Mr. BEVILL. When did you stop buying their power?

Mr. LONGENECKER. We stopped buying power from TVA last August, August of 1985.

Mr. BEVILL. And you're still paying the $450 million a year—

Mr. LONGENECKER. Yes, sir.

Mr. BEVILL. You get nothing for that.

Mr. LONGENECKER. That's correct. Under our contract we have 4,485 megawatts of capacity under contract. The contract is a take or pay contract which has an eight year adjustment period. When we saw the demand beginning to slip, or my predecessors did, they began dropping that power. And we are not down to zero until 1994.

Mr. BEVILL. You can't even get power for your $450 million? You can't get any power for that?

Mr. LONGENECKER. We could, Mr. Bevill, but buying that power would be more costly than buying the same amount of power from OVEC in Ohio.

Mr. BEVILL. That's difficult to understand since you're paying for it.

Mr. LONGENECKER. It's rather like owning an automobile, if you will. You've got your car payment and you've got your gasoline bill. And the fact is under the TVA contract, whether we drive the car or not, the payments still have to be made. And that is so great that it overwhelms the cost of power in Ohio.

Mr. MYERS. Well, I'm a country banker and you sure overpowered me there, I tell you.

Mr. LONGENECKER. You're paying $36 per megawatt hour for power if you take it from TVA.

Mr. MYERS. Well, you're paying for it whether you get it or not. Why don't you get the minimum?

Mr. LONGENECKER. No, sir.

Mr. MYERS. You're paying for it.

Mr. LONGENECKER. Using my car analogy, the car payment is about $11. Of that $36, you must pay the $11 whether you take it or not.

Mr. MYERS. That's right.

POWER COSTS

Mr. LONGENECKER. To take one megawatt hour, I've got to pay an additional $25. And I can buy the same megawatt hour for $18, energy plus demand, in Ohio. So by not taking the TVA power and by buying power in Ohio, I can save $7 per megawatt hour.

Mr. MYERS. Did you ever work for the General Accounting Office? Surely you did with that kind of analogy.

Mr. LONGENECKER. No, my past is splotched, but not quite that disreputable.

Mr. MYERS. I mean, using your analogy—if the Chairman will yield.

Mr. BEVILL. Yes.

Mr. MYERS. If I'm making a car payment, and because I'm paying too much for that car I'm not going to put it up on a block someplace and go rent a car someplace else because I can get it cheaper. I'm going to use the car I've already paid. I don't know why in the world you don't buy that $450 million worth of kilowatt hours. You're paying for it, you might as well take it. And you reduce the amount of money that you're paying someplace else.

That's where the Government's in a heck of a shape because you guys all start to shake your heads.

Mr. VAUGHAN. Let's try it again.

Mr. MYERS. You're going to have to come up with a sharper pencil than that to prove it to me.

Mr. VAUGHAN. Let me try it. There are two components of your electricity price if you take it. There is a capacity or demand charge, which is a minimum number, and then there is an incremental or energy charge above that if you take the power.

In the case of TVA, to make up the approximately $36 per kilowatt hour, there's a base charge of like $11 per kilowatt hour, approximately. That's the amount that you pay whether you take the power or not. Then, if you're going to use their electricity, you pay an additional $25 per kilowatt hour. I think that sums to $36.

Now, your choice in buying power, then, is whether to buy that incremental amount of power at $25 per kilowatt hour from TVA

or to buy it for $18 per kilowatt hour from the other power supplier.

Mr. MYERS. Would you provide for our record, in actual dollars, what you are paying now and what it would cost you, and show the kilowatt hours you're using?

Mr. VAUGHAN. Yes. The following table shows the kilowatt hours of electricity used and the cost of purchasing electricity at each gaseous diffusion site.

[The information follows:]

FISCAL YEAR 1981–85 PURCHASED POWER AND UNIT COST OF POWER BY SUPPLIER

FY	TVA [1]		EEInc [2]		OVEC [3]	
	MW-hr	mills/kwh	MW-hr	mills/kwh	MW-hr	mills/kwh
1981	13,890,674	28.96	2,445,743	22.06	6,872,044	20.70
1982	15,728,228	32.78	662,491	19.13	6,869,443	19.24
1983	15,347,174	33.08	1,077,030	20.89	6,875,144	18.77
1984	10,075,647	34.51	6,253,344	22.28	9,668,732	17.74
1985	3,988,819	34.64	7,482,137	22.99	13,270,483	17.74
1986 (est.)	876,000	36.34	6,438,600	24.14	11,388,000	18.73

[1] TVA supplies Oak Ridge and Paducah.
[2] EEInc supplies Paducah.
[3] OVEC supplies Portsmouth.

FISCAL YEAR 1987 ESTIMATED UNIT COST OF POWER

	TVA	EEInc	OVEC
Capacity [1]	11.78	4.80	4.49
Energy [2]	25.18	20.10	14.61
Total	36.96	24.90	19.10

[1] The capacity charge is the "fixed" charge which is paid by DOE wehter or not it purchases any energy.
[2] The energy charge is the "variable" charge which is paid only when DOE actually purchases electricity.

Mr. MYERS. I see what you're saying here, but have you ever tried to negotiate the contract?

Mr. VAUGHAN. Well, over the last several years we have tried a number of things with TVA to obtain some relief from that demand charge.

Mr. MYERS. What was the date of that contract where you entered into this?

Mr. VAUGHAN. It's in the early—it's in the 1970's.

Mr. MYERS. Well, would you get the exact date?

Mr. VAUGHAN. We'll get the exact date.

Mr. MYERS. And when did you first start telling TVA you weren't going to buy their power? Would you provide those dates, too? You don't know offhand.

Mr. VAUGHAN. I think it's 1981.

Mr. LONGENECKER. 1983 was the first——

Mr. MYERS. There's a big difference between 1981 and 1983, because we're also funding TVA, you see. So we'd like to have—the committee would like to have those exact dates when you first told TVA that you weren't going to need their power, and started cutting back the purchase of power, the date of the contract, give us those facts.

Mr. VAUGHAN. We will provide a history of DOE's contracts with TVA.

[The information follows:]

NEGOTIATING HISTORY—DOE/TVA POWER CONTRACTS

Oak Ridge Contract No. DE-AC05-760R03760 (TV-30613A)

Paducah Contract No. DE-AC05-760R03761 (TV-30614A)

The two contracts were negotiated in 1967 and entered into on December 1, 1967. These base documents, for the most part, remain in effect today; however, certain provisions such as contract demand, term, cancellation rights, power factor and rates have been changed with time. All changes have resulted from negotiations by the parties except for changes in rates. TVA has used it unilateral right to change DOE's rate as the standard industrial tariff has changed. All operating provisions, points of delivery, metering, resale rights, in-lieu-of tax credits and force majeure remain in effect. These contracts provided the vehicle for DOE's contract demand to increase to 3165 megawatts (MW), which was accomplished October 1, 1981.

On September 10, 1973, the contracts were modified to provide an additional 395 MW no later than October 14, 1983, to restore the Oak Ridge, Tennessee, and Paducah, Kentucky, Gaseous Diffusion Plants (GDP's) to their "full power" loads. Other pertinent changes were extending the term from June 3, 1992, to June 30, 1995, increasing the cancellation notice period from 5 to 8 years and increasing the amount DOE can cancel in any 1 year from 800 MW to 1000 MW in total. The minimum power factor at both sites was changed to 95 percent.

On March 29, 1974, and June 13, 1974, the Oak Ridge and Paducah contracts were modified to provide an additional 435 MW and 490 MW, respectively, not later than May 14, 1984, and July 30, 1984. These increases were to provide power requirements for the fully uprated GDP's and came into effect on the previously stated dates.

On December 24, 1981, 1982, 1983, and 1984, DOE has given notice to reduce the contract demand by 1000 MW each year and on March 7, 1986, by 485 MW from a total of 4485 MW to zero MW on March 7, 1994. On that date, the contract demands will have been reduced to zero MW at both the Oak Ridge and Paducah GDP's.

Mr. MYERS. We're going to start putting other agencies together with this. Thank you, Tom.

Mr. VAUGHAN. We'll also, if you would like, provide with that a summary of some of the things we have suggested over the years that we might do to get relief from that contract.

Mr. BEVILL. Who did you suggest it to?

Mr. VAUGHAN. TVA.

Mr. BEVILL. How about putting a copy of that TVA contract in there, too, that you cancelled last August? We'd like to have a copy of the contract in the record, too.

Mr. VAUGHAN. All right.

[The information follows:]

ATTEMPTS TO RENEGOTIATE TVA DEMAND CHARGES

Unsuccessful attempts to obtain relief from TVA capacity charges have been underway since 1980. Items which DOE has considered include outright relief from the capacity charges; resale of TVA power by DOE and/or purchase of power from other utilities; utilization by DOE of seasonal and/or unfirm power from TVA; near-term relief in exchange for additional contractual arrangements beyond the terms of the current power contracts; and the bartering of goods and services. To date, no solution to the excess power under contract problem has been found. There are essentially two roadblocks to a solution; first, TVA's stated belief that resale of the excess DOE contract demand is in violation of the TVA Act and, second, that any reduction in DOE's obligations would increase the obligations of the other TVA customers.

TVA was informed in the first quarter of calendar year 1980 that DOE would not be purchasing its full contract demand in FY 1981.

GOVERNMENT INVESTMENT IN ENRICHMENT

Mr. BEVILL. Well, Mr. Secretary, we listen to you all. We take your advice. You are the leaders in the energy program of our nation. And then we pick up yesterday's newspaper and we see where there's a $7.5 billion deficit over the past 14 years, according to this quotation here from one of the committees, in the March 11th "Washington Post."

I don't know of us ever giving more money than you've ever asked for in these programs. We've always given less. We may give as much, but do you recall us ever giving you more money on anything that you've asked for?

Mr. VAUGHAN. I think in this program, since it is typically in recent years a net zero appropriation, that you've given us what we've asked for.

Mr. BEVILL. Well, we've pretty well followed your advice. Now, would you explain to us here what's happened on this—we'd like to know more about this allegation of a $7.5 billion deficit over the past 14 years.

And Congressman Whitten here says there were all these critical reports, but they had a strategy to keep us always going. And he says I don't think you can conclude anything except mismanagement. Congressman Sikorski called the DOE's proposal for writing off the debt a $4 billion heist of the Treasury by the nuclear power industry with the DOE driving the getaway car.

Nuclear utilities aided and abetted the fix we're in by pushing the DOE to build new facilities. So we're getting concerned when we look at the tremendous investment we have up there at Portsmouth. Just tell us what's happened there.

Was that a mistake?

Mr. VAUGHAN. Let us both contribute to that answer, if we could, because that's a very key question.

Mr. BEVILL. Yes. Because it looks like the part we played was listening to you.

Mr. VAUGHAN. First of all, we do not agree with Mr. Whitten's allegations of mismanagement, just to respond on the record since you asked me the question. Secondly, it is not a question of creating a debt in the traditional sense of the word debt, but rather consideration of the cumulative financial effect of Government investments in the program since 1969.

The value of our assets does create an actual deficit or an actual contribution to the Federal deficit as one might imply from reading the article. Separately, most of the costs of the plants and their operation have been expensed from funds in the annual budgets.

INVESTMENT IN GCEP

Mr. BEVILL. Would you put in the record what the Portsmouth facilities up there cost our Government? How much did we invest, and how much did it increase the deficit? You mentioned and I assume you're talking about some of the enrichment fees collected. Is that from the utilities?

Mr. VAUGHAN. Yes.

[The information follows:]

GCEP INVESTMENT

Through September 30, 1985, the Government spent $2.589 billion in constructing GCEP plus approximately $150 million to complete termination activities. These outlays occurred in FY 1976 through FY 1985. In most of these years, GCEP outlays were offset by the collection of revenues from the sale of enrichment services to utilities. Therefore, GCEP construction costs did not materially impact the Government's deficit.

Mr. BEVILL. Is that what you're referring to? Well, you'd have a record of that. Give us that. We'd like to know just how much this mistake the Department of Energy and the Congress, I believe you said, made. And also, maybe you could just tell me, respond to this. What mistake did Congress make other than listening to you?

Mr. VAUGHAN. If I understand the specific question you just asked, I think you're referring specifically to the GCEP facility at Portsmouth.

Mr. BEVILL. Yes.

Mr. VAUGHAN. All right.

Mr. BEVILL. $7.5 billion——

Mr. VAUGHAN. Let Mr. Longenecker amplify a little bit of what's in that constructed number.

Mr. BEVILL. Yes. Mr. Longenecker is quoted in here. Let's see, Mr. Longenecker said:

Both the DOE and Congress were responsible for wrong decisions having to do with the enrichment facility construction in the 1970's and early 1980's that led to the deficit. We did not do this in a vacuum. Each year Congress appropriated money on it.

Mr. Longenecker, I wish you'd explain that. My question is, what did we in the Congress do other than make the mistake of listening to you?

Mr. LONGENECKER. First of all, I don't believe that's an accurate quote. But what you did was accept the projections that the Administration presented for increased electricity growth and increased nuclear power growth throughout the country. We were wrong.

Mr. BEVILL. And that made us wrong because we listened to you.

Mr. LONGENECKER. Yes, sir. We were wrong——

Mr. BEVILL. So that's really the role Congress played. When you say the Congress and the Department of Energy were wrong, the Congress' mistake was listening to you, right?

Mr. LONGENECKER. Mr. Chairman, the context of the question they asked was whether GCEP was, in fact, a mistake for which our customers should pay since they were responsible. My reaction to that question was that it was not a customer mistake. We, the Government, made the decision to construct GCEP, and it is a mistake that we should recognize. Not recognizing it and trying to recover the value of those dead assets would make us more noncompetitive. We would likely lose the uranium enrichment business in this country.

It was clearly not a mistake for which we can blame our customers. It is one that we, the Government, must bear the responsibility for. Viewed in 20/20 hindsight, if we had known ten years ago, when GCEP was initially authorized, that energy demand would be what it is today, and that we would have had the dramatic retrenchment in the nuclear industry throughout the world that

we've seen, we would not have recommended GCEP to you. But I say that having perfect hindsight.

Ten years ago people didn't anticipate the change in the oil market or in the other fuel markets that we've seen. GCEP was just a mistake that we must recognize. It was done in the past; it has nothing to do with this year's deficit since all GCEP costs are sunk.

FUTURE PRODUCTION

Mr. BEVILL. Now, what are your plans in the future? If I understand you, the plans are to, in a couple of years, to dispose of this equipment and dispose of these buildings and get whatever you can for them up there in Ohio, the Portsmouth facility as we call it.

Now, where are utilities going to get their enriched uranium from? Where are they going to get that after the sale?

Mr. LONGENECKER. Mr. Chairman, between now and the turn of the century, the majority of the production for our military and civilian customers will come from the gaseous diffusion plants.

Mr. BEVILL. Well, let's see, I heard something about the two year proposal. Did I misunderstand you, or are you talking about keeping this facility at Portsmouth going for a couple of years?

Mr. VAUGHAN. Let's separate two things, please, Mr. Chairman. First of all, we've been talking here for a few minutes about the GCEP plant.

Mr. BEVILL. Yes.

Mr. VAUGHAN. Already existing at Portsmouth is a gaseous diffusion plant.

Mr. BEVILL. Is it producing——

Mr. VAUGHAN. It is producing now.

Mr. BEVILL. Enriched uranium?

Mr. VAUGHAN. It's producing enriched uranium. It has been for some time for both civilian and military purposes.

Mr. BEVILL. So you're going to close down the GCEP.

GAS CENTRIFUGE ENRICHMENT PLANT

Mr. VAUGHAN. The GCEP plant, which is the one to which you refer, is the plant that last June we announced we were going to terminate. The real question is, should we have stopped it sooner? Certainly neither you nor we made a purposeful mistake. We operated on the best information we had in terms of projections and demand. That project is not and was not completed.

When we terminated it last June, we elected to stop a project that would have cost us even more money than had already been sunk, and would have, therefore, not been the best use of funds. And so, the buildings exist, only a portion of one of the buildings—a relatively small portion—is equipped.

It is in the calculation of the total investment that gets referred to as $7.5 billion. In terms of continuing cost recovery from our customers, and in accordance with normal accounting principles——

Mr. BEVILL. Well, I better let you finish that on the record because I want to recognize Mr. Myers.

Mr. VAUGHAN. All right. But I want to separate the two plants at Portsmouth.

Mr. BEVILL. Yes.

OAK RIDGE GASEOUS DIFFUSION PLANT

Mr. MYERS. Thank you, Mr. Chairman. Years ago, this committee funded upgrading of gaseous diffusion, which was a classified process that none of the world had, and it did tremendously reduce the cost per SWU because we had upgraded the gaseous diffusion plants. Now you're shutting them down, or are in the process of shutting them down, is that correct?

Mr. LONGENECKER. Oak Ridge is in standby, Mr. Myers.

Mr. MYERS. Standby. Well, that means it could be activated and—but you're not producing any SWUs there today.

Mr. LONGENECKER. That's correct.

Mr. MYERS. That's where we upgraded, as I recall, back ten years ago or so.

Mr. LONGENECKER. We upgraded all three; Portsmouth, Paducah, and Oak Ridge.

Mr. MYERS. But we still are producing at Paducah and Portsmouth also.

Mr. LONGENECKER. That's correct.

GCEP INVESTMENT

Mr. MYERS. Now, the GCEP, there is no production coming out of GCEP at Portsmouth at all today?

Mr. LONGENECKER. No, sir.

Mr. MYERS. None whatsoever?

Mr. LONGENECKER. It never entered commercial operation.

Mr. MYERS. Now, we visited there, the committee did, a few years ago and we were shown 5 or 7 buildings. You had, I think, three of them built or two of them anyway at that time. Is there equipment—are the centrifuge fixtures in those buildings yet? They were putting some in at the time, as I recall. We were there, Tom, remember?

Mr. BEVILL. Yes, they were building them up.

Mr. MYERS. You had some centrifuge units going in. Are they in the building?

Mr. LONGENECKER. Yes, sir.

Mr. MYERS. How many units do you have in those buildings today?

Mr. LONGENECKER. There are about 1,380 at Portsmouth, and we have about 120 centrifuges still installed in the test cascade at Oak Ridge. So we have about 1,500 in total.

Mr. MYERS. But they are not operating at Portsmouth.

Mr. LONGENECKER. No, sir.

Mr. MYERS. They're in the building.

Mr. LONGENECKER. Yes, sir.

Mr. MYERS. Is there anything more to be done with those to put them in operation?

Mr. LONGENECKER. Yes, sir. It would require finishing the feed and withdrawal facility and completing enough of the facility to make it operational.

Mr. MYERS. What would that cost be?

Mr. LONGENECKER. Several hundred million dollars.

Mr. MYERS. Several hundred. That could be $200 or $700 million. Didn't you ever figure what the cost would be to complete that?

Mr. LONGENECKER. Yes, sir. It depends on the amount of capacity that you want from the plant.

Mr. MYERS. How much capacity. You're limited right now by the number of cascades you have there. So what would that cost to put those—to build just enough to have those units operating and producing SWUs?

Mr. LONGENECKER. For a half of a building it would cost, my guess would be, about $150 million.

Mr. MYERS. Can you go back and get us more than just a guess?

Mr. LONGENECKER. Certainly.

[The information follows:]

COST TO OPERATE GCEP

An analysis of the cost to start up the Gas Centrifuge Enrichment Plant in its present condition is being prepared and will be provided to the Subcommittee in separate correspondence.

Mr. MYERS. Provide that. Now——

Mr. VAUGHAN. What he said is important—of the buildings that are there, there are centrifuges only installed in one-quarter of one building.

Mr. MYERS. Yes. How many do you have purchased that you haven't installed, too? Do you have some equipment purchased that you haven't put in place?

Mr. LONGENECKER. We have a total of 1,500 machines. Some of them are at Oak Ridge that could be installed at——

Mr. MYERS. No, I'm talking about Portsmouth. Let's forget about those that you—you mean you're going to build more at Oak Ridge also?

Mr. LONGENECKER. No, sir. Some of those machines, were we to decide to operate GCEP, could be shipped to Portsmouth. And the total would be 1,500 machines.

Mr. MYERS. Okay. What the committee would like to have is what you have invested so far in GCEP equipment, and what it would cost to make that existing equipment functional and producing SWUs. That's two figures we're asking for so far.

PRODUCTION COSTS

Now, in production costs, I believe you gave a figure that with gaseous diffusion you could produce a SWU for $36. Is that what you said?

Mr. LONGENECKER. At Portsmouth, $35 per SWU is the marginal cost.

Mr. MYERS. And——

Mr. LONGENECKER. The reason for terminating GCEP, Mr. Myers, was that any completion case for it would have a production cost substantially higher than GDP marginal costs.

Mr. MYERS. We can figure that. That's what I'm trying to get to. We've already got the investment, and I'm afraid what you may have done is forget about the present investment and just figure what it would cost you to start it from scratch.

We did that years ago, the Congress did, with some airplanes we were going to build. Remember the—no, you don't remember. But anyway, we forgot the $2 billion we already had invested. It cost us more to terminate those airplanes than it would to have them fly. We also did that with the Senate side with a building over there. We had so much invested in one building, that we were about to scrap it and finally some sane people did find their way and said my gosh, let's go ahead and have it. And that's what I'm wondering if you people have done.

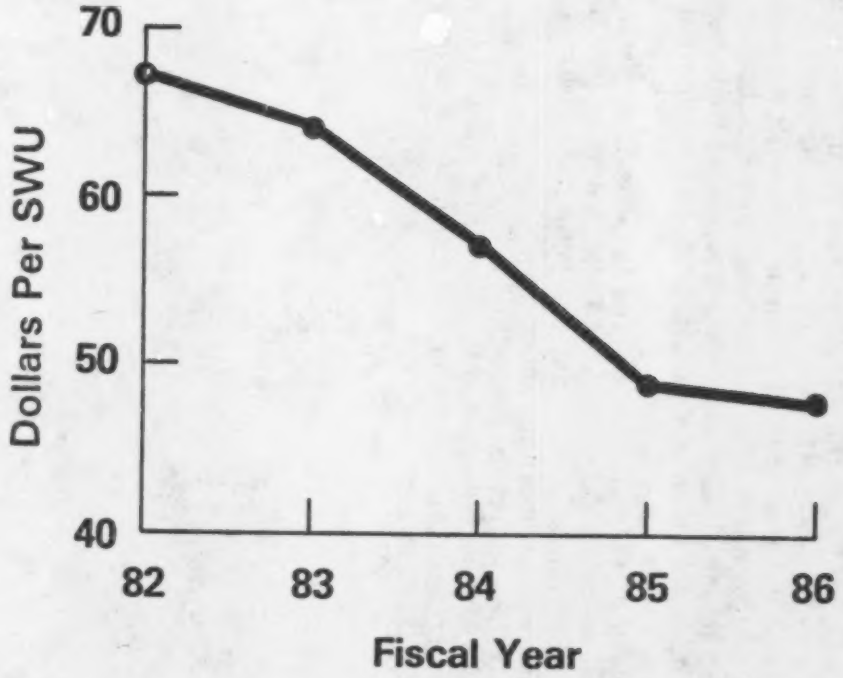
Now, don't pad your figures because I've given you—obviously what we're looking for. You know, what I'd like to see is dollars, not the things here. What are your total costs of—back in 1982, that's what, something under $70.

Mr. LONGENECKER. About $70.

Mr. MYERS. Now divide that up. How much of it was actually operating production cost and how much of it was overhead?

[Chart follows:]

Declining Energy Costs to the GDP's



Mr. LONGENECKER. That's only electricity cost in that chart.

Mr. MYERS. That's all electricity?

Mr. LONGENECKER. Yes, sir.

Mr. MYERS. Can't you just come in and tell us what stuff costs sometimes? These charts are—you know, you didn't start from zero on some of them, you start at 50 percent on others, and I don't know whether you're intentionally trying to mislead the committee or not, but you're sure getting it done. Maybe you have. Maybe that's what the Chairman was asking about a while ago.

Mr. VAUGHAN. We surely, Mr. Myers, are not trying to mislead the committee. We never have and never will.

Mr. MYERS. Well, I was a country banker—and I keep going back to that. If somebody came in with figures like this, I'd throw them out of the office and wouldn't think of making them a loan if they couldn't tell me the truth and tell me all the figures.

Mr. LONGENECKER. What's your question, Mr. Myers?

Mr. MYERS. Well, I go back. What is the total cost of SWU in 1982 divided between the actual operating production costs and what your sunk overhead costs were? You'll provide it for the record. And when what it is today. You say it's $35 today. Well, what actually today is in that $35? Now, is it just electric charges or is that total cost?

Mr. LONGENECKER. The cost components of a SMU in 1982 versus the current costs as well as the SMU price and SMU price components are shown in a table that I would like to insert in the record.

[The information follows:]

SWU COST COMPONENTS

[Dollars in millions]

SWU Cost Components	Fiscal year—	
	1982	1986
Power	$655	$373
All other	149	125
Depreciation	88	36
Total	892	534
Millions of SWU product	9.78	7.6
Unit Cost in dollars per SWU	91	70

SWU PRICE COMPONENTS

[Whole dollars]

SWU Price Components	Fiscal year—	
	1982	1986
Power	$56.40	74.42
All other	33.36	27.36
Depreciation	5.93	6.53
Interest	35.06	16.69
SWU price	130.75	125.00

Mr. LONGENECKER. In the chart which——

Mr. MYERS. I don't give a darn about the chart. What are the actual costs of producing a SWU?

Mr. LONGENECKER. If you flip back one chart, you'll find the total——

Mr. MYERS. I've already thrown your charts out. I want the figures now.

Mr. LONGENECKER. It's about $70 a SWU to produce——

Mr. MYERS. It's not $35, it's $70 today.

Mr. LONGENECKER. It is the——

Mr. MYERS. See, we're getting different figures all the time. I don't know how in the world you can expect us to make a sound decision when you don't use the same—you use cats and dogs.

PRODUCTION COSTS

Mr. LONGENECKER. In our business analysis, Mr. Myers, to consider whether we should build GCEP or operate the GDP, we did a marginal cost analysis that assumes that you operate gaseous diffusion plants to produce a fixed quantity, say 8 million SWUs. Then the question is, if you can operate GCEP and get another half million SWU's from it, what is the avoided cost at the gaseous diffusion plants? It is not the total cost of about $70 per SWU, it is only the energy cost that you are avoiding by not producing half a million SWUs there and producing them in the GCEP.

So the average cost is about $70 a SWU. The marginal cost, the cost that you avoid, the cost of producing additional SWUs, is $35.

Mr. MYERS. Well, let us figure that. Let us——

Mr. VAUGHAN. Two things are important to keep in mind in what he just said here.

Mr. MYERS. You'll give us the dollars of what you already had invested.

Mr. VAUGHAN. Yes. If we were to operate GCEP, the total capacity there for the machines that are installed is only about half a million SWUs per year. And so, what you're trying to figure is whether that small amount of SWU's, could be produced as cheaply in operating that plant just for that purpose, as could the last half a million you could produce in your plants that are already operating to produce your first 6 million or 7 million or 8 million, or however many you're producing that year.

ENRICHMENT PRODUCTION

Mr. MYERS. In 1991, to meet this 53 percent of world purchase of SWUs, how and where is it going to be produced?

Mr. LONGENECKER. The production will come primarily from the Portsmouth and Paducah gaseous diffusion plants.

Mr. MYERS. The capacity is already there for that much.

Mr. LONGENECKER. Yes, sir.

Mr. VAUGHAN. Yes.

Mr. MYERS. Now, the equipment you have purchased; the buildings can be sold for some figure, but the centrifuge, the cascades that you already have purchased, what are you going to do with them?

Mr. LONGENECKER. Well, there are a number of potential alternative uses. The military has expressed an interest in using the cen-

trifuges for high enriched uranium clean up. The Air Force has expressed interest in using the facilities and land that we have at Portsmouth for an Air Force logistics command center. And we have received——

Mr. MYERS. Well, I'm talking just about equipment now. The building can be used for many things, but the equipment, the——

Mr. LONGENECKER. The centrifuges.

Mr. MYERS.—the centrifuge equipment.

Mr. LONGENECKER. The military could potentially use the SET-III machines and some of the equipment for clean up of HEU. We do have a preliminary expression of interest from a private sector organization that might be interested in using them for low enriched uranium production.

WORLD ENRICHMENT MARKET

Mr. MYERS. I'm going to get back to this TVA, but I want to continue on this Portsmouth problem we have here. You say that 21 percent of the world's demand market for SWUs is still uncommitted in 1991.

Is that domestic or is that——

Mr. LONGENECKER. That is total free world.

Mr. MYERS. How much of it is domestic?

Mr. LONGENECKER. It is a very small portion of that total. The primary uncommitted market now is in Europe and in the Far East.

Mr. MYERS. Are those individual users or are they partial contracts of existing users today?

Mr. LONGENECKER. They're both.

Mr. MYERS. There are some buyers that just are not going to commit, is that what you're saying?

Mr. LONGENECKER. That's correct, not ten years in advance. As you know, there's a large spot market and some customers are buying from the spot market. It is primarily, though, users who are diversifying a portion of an existing contract who represent the majority of that uncommitted demand.

AVLIS PROGRAM

Mr. MYERS. AVLIS is still to be proven. We think it's going to work. Last year we made a decision to scrap the Portsmouth GCEP, and now you're hoping somebody will buy AVLIS. But the tremendous cost and betting on the come, I'm not sure—have you got any potential buyer for AVLIS?

Mr. LONGENECKER. We do not have a firm expression of interest as of this date.

Mr. MYERS. Yet, AVLIS hopefully will be the next generation. We had the gaseous diffusion and we had the upgraded gaseous diffusion, then we went to centrifuge, now we're going to go to AVLIS. By 1991, when we might be making a decision, we're going to have something else. We're going to build a new one, and then we're going to say oh my goodness, we made a mistake with AVLIS. Just as sure as God made little green apples that's going to happen.

Mr. LONGENECKER. Mr. Myers, I——

Mr. MYERS. Then they're going to come back and blame you and Congress for making the decision to go with AVLIS.

Mr. LONGENECKER. I don't believe so. If you look back ten years ago, we——

ENRICHMENT HISTORY

Mr. MYERS. We were here ten years ago. Tom and I were on the committee.

Mr. LONGENECKER. We overestimated.

Mr. MYERS. Centrifuge was the only show in town. Oh, we've got to go centrifuge. We visited—the committee went down and visited the gaseous diffusion when they were upgrading there, and we had to swear we'd never tell anybody how it was done. All of a sudden they showed these little things standing about as tall as this room and said now, this may be, this could be—just as you're telling us about AVLIS today—this could be the future. Then a couple of years later it is.

Now we've built the ones in Portsmouth. And then all of a sudden we say oh, we made a mistake. Now, I'm saying there will be something better than AVLIS.

Mr. LONGENECKER. And I disagree with that.

Mr. MYERS. I hope there is.

Mr. LONGENECKER. I disagree with that. In those days, you recall that the Atomic Energy Commission's plan was to build one GCEP-type plant every 18 months. That's how vigorous we thought nuclear growth was going to be. So GCEP was needed for new capacity. We thought we needed GCEP plus another one every year and a half. What we found was we didn't need any new capacity. Then the Department tried to make it an economic replacement for a gaseous diffusion plant.

So, as gaseous diffusion costs have gone down, GCEP economic justification went away. The conclusion we came to after a year and a half of analysis was that if we operated GCEP, although we didn't need the capacity, that it could not be operated at a lower cost than the avoided cost of gaseous diffusion. We were wrong ten years ago on needing GCEP for capacity, and we then found that we could not make it an economic alternative to gaseous diffusion.

If you look at AVLIS, it is a much simpler, lower cost process.

Mr. MYERS. Ever hear that before?

Mr. LONGENECKER. —you have the French who——

Mr. BEVILL. If the gentleman would yield. We're closing down GCEP, right, because gaseous diffusion is better, right? Gaseous diffusion is the best now. You can produce it cheaper.

Mr. MYERS. Not really.

Mr. LONGENECKER. It is. On an economic basis it is. It is cheaper than investing in a new centrifuge plant.

Mr. BEVILL. Now, what's going to happen next? I'm looking at the chart now to what's happened in the past. We're going to suddenly find out and our utilities are going to find out they can buy enriched uranium someplace cheaper, in Europe and other places. So then we're going to have a few billion tied up in gaseous diffusion and we'll have to be closing that one down.

Do you think that prediction makes sense? I'm kind of looking at—basing the future on what's happened in the past.

Mr. LONGENECKER. No, sir, I don't believe so. The decision we made on GCEP was not to invest in a new plant or not to invest in new technology now. The gaseous diffusion plant costs are sunk—you know, they're over 30 years old and they're paid for—it's cheaper to buy electricity and operate them than it is to invest in a new plant now.

In the future, however, as electricity prices increase, the cost of gaseous diffusion will eventually make us noncompetitive. We think that's about the turn of the century. And then, we believe that investment in AVLIS will make sense.

Mr. VAUGHAN. Now, there is one mistake, Mr. Chairman, in the GCEP case. Because people collectively believed that there were the needs for the demand, they proceeded to commit to construction somewhat in parallel with finishing the research, development, and demonstration of the basic process.

AVLIS PROGRAM

We do not intend to follow that path on AVLIS. We intend, whether it's Government or private sector investment, to get the development and demonstration completed and be more certain of what we can do prior to committing to major construction projects.

Mr. BEVILL. Now, if AVLIS is so good, why aren't we using it now? If I understand you, it's going to be— gaseous diffusion now is the thing, but AVLIS is next.

Mr. VAUGHAN. In our findings last June, Mr. Chairman, we made it very clear that neither the advanced gas centrifuges, which were beyond those that were planned for Portsmouth, nor the AVLIS process was ready to deploy. AVLIS was a choice made on potential. We identified and have a plan for the next several years to complete the research, development, and demonstration to show that on a scaled up basis you can do it more economically. It is our intent that that work be completed before a decision is made to deploy.

As I commented a while ago, we, in hindsight, which is wonderful, probably made a decision to deploy GCEP before we had the data to do it.

PORTSMOUTH GASEOUS DIFFUSION PLANT

Mr. Myers. Well, the Portsmouth gaseous diffusion plant is primarily for naval reactors fuel. Am I not correct on that?

Mr. LONGENECKER. No, sir. It is the only facility that can produce HEU, but the majority of its output is low enriched uranium.

Mr. MYERS. It is. But it does produce reactor fuel for the Navy.

Mr. LONGENECKER. Yes, sir.

Mr. MYERS. It also does that. Which the GCEP was going to produce also, was it not?

Mr. LONGENECKER. No, sir. The GCEP was not to produce HEU.

Mr. MYERS. Maybe my memory fails me, I guess.

Mr. VAUGHAN. It could have been adapted to produce HEU, but the intent in building the plant was for civilian capacity.

Mr. MYERS. Now, I believe you earlier testified that the centrifuge produced fuel is still cheaper than gaseous diffusion if you just consider the operating costs, am I correct on that?

Mr. LONGENECKER. The operating cost of centrifuge——

Mr. MYERS. The electric power to produce a SWU is cheaper with the centrifuge.

Mr. LONGENECKER. Yes. The electricity requirements are about five percent of gaseous diffusion to produce a SWU using centrifuge technology.

Mr. MYERS. Then why is centrifuge more expensive than diffusion?

Mr. LONGENECKER. The capital cost to build a new plant is overwhelming. We were faced with an estimate of $5 billion to complete GCEP.

Mr. MYERS. Now, I guess what you're saying, telling the committee, here is that the size at Portsmouth would not be an efficient size to operate. Is that what you're saying? The size of production there and the cost of the—the unit cost, as you were saying, Mr. Vaughan, is——

Mr. VAUGHAN. The cost per SWU varies as the size of the plant varies.

Mr. MYERS. Well, how many have we already purchased? Is it one of those things you may stop buying but you have to go ahead and pay for them anyway because you promised them? Is it going to be another TVA?

Mr. VAUGHAN. No. As a matter of fact, when we terminated the program last year, the vendors mutually, in agreement with us, asked to terminate production and get the facilities cleaned out so that they could use them for other purposes, rather than completing the contracts. And that was a net less cost to the Government.

Mr. MYERS. We have not had and did not have any termination costs associated with the purchase of the centrifuge and the associated equipment?

Mr. LONGENECKER. No, sir.

Mr. VAUGHAN. No, sir, I did not mean to say that. There were termination costs.

Mr. MYERS. Would you provide all of this, what it's cost us so far, this big mistake? You see, what we were told years ago, and we went out on the field. And we get criticized for travel by the press quite often, but if we don't go out, we catch heck, too. But, we asked for the job and you did, too.

But we were told this is a brand new—five percent of the cost. We've got to go centrifuge. Then we get hung out here. We build centrifuge, and all of a sudden you say oh, we can't do it because gaseous diffusion is going to be cheaper. Now you're going out on the market and say we're going to capture a bigger percentage of the world market in 1991. Yet, we're still going back to the old system. And then you tell us well,—the Chairman says, and he may be right—we're going to lose competitiveness by then because other countries are going to produce it and leave us like the Netherlands is right now, and Britain, they're building the centrifuge, big units. We visited over there and they wouldn't let us look at them, but I guess maybe they've been ashamed of the size of them.

I don't know why. But we couldn't visit and see their's. But nevertheless, they are building them.

Are we going to get—are we getting hung out here and say well, we're going to bet on the AVLIS now? That's what my concern is, that we're going to be hung out here on the AVLIS in the future. I'm concerned about what we already have invested, how many units we have, how large the unit would be if we took all—what are there, Portsmouth today or Paducah—if we took those that aren't installed and installed them. We've already bought the doggone things, what size will the unit be, and how many SWU's we can produce, and what this costs us to do that.

Well, I've got a couple of other questions. Has the General Accounting Office ever audited your system of allocating charges?

Mr. VAUGHAN. Continually.

Mr. MYERS. Not that I'm suggesting they should. I just wonder if they have.

Mr. VAUGHAN. Continually.

Mr. LONGENECKER. They did, Mr. Myers, audit our means of allocating costs between the civilian and the military in 1984.

Mr. MYERS. Well, they're concerned about that, yes. Well, they're interested in cost. They're always interested in these things about—the military, if they can. But what your actual costs are and ascertaining if it could be done better.

GCEP ECONOMICS

Mr. LONGENECKER. They have audited the program and they do have a continuing audit underway. If I could respond to your question, you're agonizing over the exact same thing that we did before the June decision. We said we have invested $2.5 billion—and that's the answer as to how much we spent on GCEP, $2.5 billion—on a facility that we thought was going to be more economical than the existing gaseous diffusion plants. And we found out we were wrong.

So, we said, how much would it take, assuming that the termination costs are sunk, assuming that the other costs, the $2.5 billion is sunk, what would it take to complete a half a building of GCEP, to operate it. Then we calculated what the average production costs would be. We looked at completing the centrifuge manufacturing contracts rather than terminating them, assuming the machines were free, and assuming we put in $40 million more to complete half a building. What we found was that if everything worked successfully, and we could complete the facility for $40 million, that this would have a positive rate of return to us. It would be slightly cheaper than estimated gaseous diffusion marginal costs.

But then we did a sensitivity analysis on that, and we saw what——

Mr. MYERS. What's a sensitivity analysis, for us farm boys?

Mr. LONGENECKER. It assesses what happens if civilian or military demand is lower, and therefore gaseous diffusion production costs are lower; what if electricity costs to the gaseous diffusion plants are lower than we had assumed in our base case; and what happens if the operating or construction cost of that half building of GCEP goes up.

And what we found was that with a very small variation in costs, the internal rate of return went to zero, or in fact, went negative.

Mr. MYERS. Well—compare that with what would be applied to gaseous diffusion.

Mr. LONGENECKER. Yes, sir. That is precisely the calculation we did. And as frustrating as it might seem, we did a quarter of a building case and we did a half building case. We looked at GCEP for military use and for civilian use. We did a two building case, a four building case and an eight building case using different technologies. None of them, from a standard investment point of view, was superior to gaseous diffusion.

We were wrong when we initiated the GCEP project. And what we did, Mr. Myers, was after doing the analysis, decided that any more money would be ill-spent. We admitted the mistake and terminated the project.

Mr. MYERS. Of the $2.5 billion charges already, how much do you expect to recover?

Mr. LONGENECKER. We spent about $700 million on the GCEP buildings, and we believe that most of those could be put to beneficial use by a non-enrichment user. About $1 biliion of it was spent on design and engineering and we do not expect that that will be recovered. We are transferring the technology and potentially some of the equipment to Defense and other Government applications. I couldn't speculate on what those figures would be.

COST RECOVERY

Mr. MYERS. So you could add probably $1.5 billion back in on the other gaseous diffusion overhead charges, couldn't you? It's questionable by the press, but they're not going to make that decision. They're going to criticize us for it.

Mr. LONGENECKER. We'll try to get as much from GCEP as we can.

Mr. MYERS. But you're going to have to add that back in on the other side. It's got to be recovered someway; either through the taxpayers or through the——

Mr. VAUGHAN. Well, that's in terms of how you view the situation. You need to remember that the annual budget expenses of the program, and by and large the cost to do the GCEP project were offset by annual revenues.

The price charged to the customer has to date specifically included a factor for interest on GCEP construction, but not on the actual investment. The asset investment becomes a factor in the SWU cost and pricing only as it is depreciated. So from that perspective, GCEP has not been recovered. On the other hand, during the years that we were investing in GCEP, the revenues returned to the Treasury included a depreciation charge from the use of the gaseous diffusion plants which required no offsetting outlay. Therefore, the revenues exceeded the program's expenditures.

Mr. MYERS. You mean it's a work in progress? You recovered work in progress? You have—do you, in your rates?

Mr. VAUGHAN. Well, we can recover the cost of the interest incurred on the investment.

Mr. MYERS. Well, that's a big issue in Indiana. We can't do it for utilities out there. But you can do it?

Mr. VAUGHAN. Yes, for the interest portion.

Mr. MYERS. Well, that's going to drive even cheaper for the——

Mr. VAUGHAN. Well, it doesn't work quite the same as it works for a utility.

Mr. MYERS. But you've recovered your costs already. Somebody has already paid for it, so that means that plant over there isn't going to cost you anything that you guys built at Portsmouth, then, is it?

Mr. LONGENECKER. We did not debt finance that facility.

Mr. MYERS. Well, I have a number of questions. Mr. Smith shows us last year that you showed $1.565 billion above revenue, appropriated above revenue.

Mr. LONGENECKER. That was both for civilian and military purposes. Some of that has to be allocated to the military.

Mr. MYERS. Doesn't the military pay for theirs?

Mr. LONGENECKER. They did not budget for their SWUs until 1983,

Mr. MYERS. But don't they pay for it as they— don't they have to pay the same rate as a commercial reactor——

Mr. LONGENECKER. No, sir.

Mr. MYERS. They pay a cheaper rate?

Mr. LONGENECKER. Yes, sir.

Mr. MYERS. They do not pay then. What costs do they not pay?

Mr. LONGENECKER. Depreciation of facilities and imputed interest. And they did not in those net appropriations estimates, budget for their SWUs prior to fiscal year 1983. So the funds that were used for production were not offset by other appropriations for defense programs.

Mr. MYERS. How much of that $1.5 billion, then, is because you were selling military too cheap?

Mr. LONGENECKER. The amount of the $1.5 billion that can be allocated to military purposes is about $1.1 billion.

Mr. MYERS. Well, I was shocked to hear that you can buy electric energy from everybody else, EEI and everyone else, for less than the price TVA is selling it to you. And I have some questions relative to the contract that you have with TVA and the dates of it and so forth, and if I have time I'll—right now I've used my five minutes, I see.

[Laughter.]

ENRICHMENT HISTORY

Mr. LONGENECKER. Mr. Myers, if I could answer one question you asked. And that was, why did we get into this situation. Well, ten years ago, as a Government monopoly, we didn't run this like a business and we were out for bigger and better centrifuge technology. And, quite frankly, when we were a monopoly we were able to do that.

What we're admitting today is that the customer doesn't care how we produce the SWUs. He just cares that the price is competitive. So what you said is uniquely true.

Mr. MYERS. I believe it's factually true also, not only uniquely true.

Mr. LONGENECKER. Uniquely and factually true. Our motivation is to be a competitively priced supplier. The conclusion we have come to is that the best way to assure that end is for us to continue to rely on gaseous diffusion, and then to assure that we have AVLIS around in the late 1990's when we think that gaseous diffusion will take us out of the competitive range.

Mr. MYERS. I thought you were right a few years ago, but—and pardon me for using the time after I yielded.

Mr. FAZIO. Go ahead.

Mr. MYERS. But we've been burned once, and now sell us AVLIS. I'm about ready to cancel AVLIS. Let's go with gaseous diffusion and let the rest of the world develop AVLIS if they're going to do it or some private sector. We were so convinced with centrifuge.

The Chairman and I were on the committee, and I think we were the only ones on the committee back then, but we were told by the people sitting in the chair just what you're telling us today about AVLIS. We were told that about centrifuge. You're asking about another pig in the poke.

Mr. VAUGHAN. Well, Mr. Myers, I'm going to say it again. I've said that as long as we can do it intelligently, we do not intend to let the deployment of AVLIS proceed in parallel with doing the demonstration to confirm both the technical and the economic aspects of it, which is not the way we proceeded with centrifuge technology. We proceeded to commit to a big construction project in parallel with completing the research, development, and demonstration. We do not intend to repeat that mistake.

Mr. MYERS. We upgraded the gaseous diffusion at that time just so we could be competitive while we got centrifuge on-line. Now we're asked to do the same thing while we look at AVLIS.

Mr. BEVILL. The Chair recognizes Mr. Fazio.

Mr. FAZIO. Thank you, Mr. Chairman. And I really don't mind waiting because I've enjoyed the show, so to speak, here this morning. After reading yesterday's paper, something I don't get to do every day, I wouldn't have missed it today.

I wanted to ask Mr. Longenecker, how long have you been with the Department?

Mr. LONGENECKER. With the Department of Energy and its predecessors, for 12 years.

Mr. FAZIO. How long have you had this assignment?

Mr. LONGENECKER. Two and a half years.

Mr. FAZIO. Did you have much to do with this program before you took the assignment you currently have?

Mr. LONGENECKER. No, sir.

Mr. FAZIO. Did they have scapegoat in your job description when you took the job?

[Laughter.]

Mr. LONGENECKER. I think that comes under other duties as assigned.

Mr. FAZIO. Other duties as assigned. And one of them is scapegoat, anyway. I'm impressed with the way you've attempted to discuss the program this morning, and I don't think anybody who has only been involved with it for two and a half years can be blamed

for it. And I know no one in the committee really wanted to blame you, but you just happen to be delivering the message. You know, we shoot the messengers sometimes.

Mr. MYERS. You know, we weren't trying to blame you two. It's the Department who misled us.

Mr. FAZIO. Yes, I think that's true, and I——

Mr. VAUGHAN. And we understand that. I'm sure you know that Mr. Longenecker and I were the key players along with the Secretary in making the hard decisions that we made last summer to stop before we got any further in the trench.

Mr. MYERS. If you would yield one more time.

Mr. FAZIO. I'd be happy to yield.

Mr. MYERS. The problem is this, is what I'm trying to say, is you're here today and telling us to go this route, just like we can't find the people now who led us down the Portsmouth path. You say 10 or 15 years from now we're going to not make that decision, but you people won't be here either. We probably won't be either, but whoever is here is going to say Congress and those people misled us.

Mr. BEVILL. I'll be here then.

Mr. MYERS. Tom says he's going to be here.

ENRICHMENT DECISIONMAKING PROCESS

Mr. FAZIO. Anyway, I only brought that up because I think the problem we're wrestling with here is endemic. It really doesn't relate to any individuals. It's a process that's gone wrong. And I would like—I mean, there's a lot of sound and fury involved in this. Anybody who looks at the situation is frustrated, and anybody who feels that they've been part of the process that's led to it can be very, very restless and uncomfortable.

Certainly I think it's fair to say that even though this committee has essentially gone along with the recommendations that were made to it, I hope we all benefit. Because actually a number of us have been here. I've been on the committee even long enough to feel that I'm not blameless. I think everybody involved in this process at the Congressional level, as well as in the Executive, would like to find ways to avoid this.

And for us, I think, to start with, we have to be more skeptical. It's only healthy skepticism. We can't simply accept what's passed to us by people who are not disinterested. I'm wondering what we're doing to make sure we don't make the kind of judgment mistakes in the future that we've made in the past. Inevitably they'll come along. And it seems to me that one of them is clearly a late realization of the degree to which we had seen a decline in the reliance on nuclear power generation for power development in this country.

Obviously there are a lot of other factors; overseas markets, the declining—well, you know, there are all sorts of other energy impacts. But we seem to go on an awfully long time at the Department of Energy on assumptions that were being challenged in many other places; in the money markets, and in decisions that were being made in the nuclear industry, certainly a lot of utility judgments.

Why did we continue to go down the road without much self-doubt, and certainly without much that came to this committee's attention? What was in the process that led us astray so clearly? And how can we prevent that from happening again?

ENRICHMENT HISTORY

Mr. LONGENECKER. Mr. Fazio, what I think you saw happen with GCEP was when the recognition struck both the Executive and Congress that nuclear power growth was substantially less than we had projected, and that the GCEP project would not be needed for new capacity, an attempt was made to change the mission of the project to be lower cost replacement capacity for one of the GDP's. That's what the advanced gas centrifuge development program was all about.

I don't think that's unlike what a company would do, having invested probably over $1 billion at that point. We tried to find some beneficial use for that capital.

Mr. FAZIO. Yes.

Mr. LONGENECKER. The initial projections at that time were that the advanced gas centrifuge technology would be good enough, and it would be better than gaseous diffusion. One of the major flaws in that analysis was it assumed that electricity costs, the primary cost component of gaseous diffusion, were going to continue to increase at over ten percent per year. Of course, what we found in the early 1980's was that they flattened out. And as you saw this morning, our power costs, by shifting our sources of supply, have gone down.

So, not only was advanced gas centrifuge not quite as economical as originally projected, but the benchmark that it had to beat was lowered substantially. I guess a good way of putting it is that we probably spent six years trying to make GCEP work for additional capacity, and then about a year and a half to two years trying to make it work as more economic capacity that the GDP before we finally decided that it was a bad investment.

Mr. FAZIO. I don't know whether private investors would have made those decisions more rapidly. I think that we were working with private enterprise. It really would be inappropriate to make judgments on what is public and what is private decision-making in this context. The industry obviously thought it had an incentive as well to work with you on this. They were not totally immune from being, perhaps, overly euphoric.

I mean, don't you think that's where some of the driving pressure came from?

Mr. LONGENECKER. Well, we picked some of the best companies in the country to try to develop that technology. But, quite frankly, had it been a private sector investment banker who made the decision, they probably would have terminated it earlier.

Influencing the Department's position, I would assume, was that we were a monopoly at that point in time, and we were able to continually raise our rates. As you saw, the customers had no alternative. So we were able to generate the cash to invest.

Mr. FAZIO. You created the market essentially. The way we operated our monopoly guaranteed that we would no longer be one.

Mr. LONGENECKER. Yes, sir; that is exactly correct.

Mr. FAZIO. As a result of that, the market now exists that we won't be able to deal with for the foreseeable future.

Mr. LONGENECKER. Well, I differ there. I believe we are dealing with the market.

Mr. FAZIO. We're reacting to it. I'm not sure we're on top of it.

URANIUM ENRICHMENT MARKET

Mr. LONGENECKER. I'm not sure that with the competition that you have today you can do anything but react to it. There's still a dramatic difference between supply and demand. There's 40 million SWU's of installed capacity, and this year the world's sales were 22 million. So you can see that all that capacity probably won't be soaked up until probably the turn of the century.

Mr. FAZIO. Right. I agree.

Mr. LONGENECKER. So all we can do is respond to the market, which is what businesses do in that kind of environment anyway.

NONPROLIFERATION ISSUE

Mr. FAZIO. Sure. Well, we're operating now belatedly with market signals, and I hope that people won't say it's simply the failing of Government. I think it's just the failing of management. I'm also frankly concerned that, you know, we will forget that we had some other values involved here. I would like to question, though, whether we've used our power appropriately in terms of the nonproliferation issue.

That was part of our motivation for staying in charge of this marketplace. But do you think we're now feeling the heat from our competitors that we're dropping our guard a little bit on the question of proliferation? I have in mind some of what, I think, a number of people questioned about in regard to our deal with China.

Are we getting so enthused about servicing the international marketplace and regaining our foothold that we're going to be a little less concerned about the question of nonproliferation?

Mr. LONGENECKER. In the uranium enrichment area I don't believe so. We're very mindful of the proliferation potential of it. It works both ways. We're very mindful on the technology side to carefully protect the gaseous diffusion, the centrifuge, and the AVLIS technology. They are highly classified and we protect them very carefully.

On the other side, one of the most important contributions that we can make to nonproliferation is providing low cost fuel to countries so that they neither build their own enrichment plants or reprocess and use plutonium. That is a key factor. There we must be a competitive reliable supplier, though, to have a positive nonproliferation benefit.

Mr. FAZIO. How many countries have left us because they didn't think we were going to be a consistent, positive supplier?

Mr. LONGENECKER. Well, in the conversion to the Utility Services contract, eight foreign customers chose not to rely on the United States.

Mr. FAZIO. Can you tell us who they are?

Mr. LONGENECKER. They were all European. I can provide the list for the record. And then seven domestic customers chose not to convert to the utility services contract. That decision is one that actually began for the Europeans in 1979 when their plants began operating. Many of them are not relying on us because our price was the highest in the world, and some of them have their own indigenous capacity.

[The information follows:]

CUSTOMERS WHO CHOSE NOT TO CONVERT TO THE UTILITY SERVICES CONTRACT

Belgium: Synatom.
Netherlands: PZEM
Germany: KKI, KWO.
Sweden: Swedish State Power Board; OKG.
Switzerland: NOK, Goesgen-Daniken.
United States: American Electric Power (Indiana and Michigan Electric), Boston Edison, Maine Yankee, Pacific Gas and Electric, Sacramento Municipal Utility District, Vermont Yankee, and Yankee Atomic Electric.

Mr. FAZIO. Sure.

Mr. LONGENECKER. But clearly, as our price becomes more competitive, we hope we can break back into that market, sustain the Far East market, and very importantly from a proliferation point of view, in the other developing countries, to secure that market share.

URANIUM ENRICHMENT MARKETING

Mr. FAZIO. We're going to be very much up against the European competition at that time, don't you expect?

Mr. LONGENECKER. I believe so, but I believe we're up to it. I think we saw we went out and competed for the uncommitted market share between 1991 and 1995, and we got 75 percent of it.

Mr. FAZIO. Why do you think we did?

Mr. LONGENECKER. Excuse me?

Mr. FAZIO. Why do you think we were successful there?

Mr. LONGENECKER. Price, or actually a combination of price and terms.

Mr. FAZIO. What kind of terms can we offer?

Mr. LONGENECKER. Well, the key terms that are important to customers are reliability and flexibility. The US contract has a substantial amount of flexibility in it that our prior contracts did not, to avoid customers having to take enriched uranium that they didn't need.

Mr. FAZIO. No take or pay requirements in this?

Mr. LONGENECKER. That's correct. That's been eliminated. And the ability to vary his tails assay, and to take advantage of cheaper uranium when he can find it. So I think that flexibility and the assurance that we bring to the market, since we are still the largest, and since we will be a reliable supplier for the future, has a great deal to do with why people rely on us.

Mr. FAZIO. That may mean, though, that we don't actually have 75 percent of that market. Until we get there, we won't know.

Mr. LONGENECKER. We have it if the reactors operate.

Mr. FAZIO. What kind of a military bailout can we look to? And I use that term advisedly. But how much of our costs here can be shifted to the defense side of our marketplace? That's the only market area that's growing, and what more can we do?

You've indicated earlier that we're now getting funds from the Department of Defense to pay for the benefits that they've been deriving. But what about future demand that they'll be placing on us?

Mr. LONGENECKER. Well, beginning in Fiscal Year 1986, we adopted an accounting and pricing structure which assures that they pay appropriate costs. They do not directly pay imputed interest or depreciation since they're another Government agency. But today they're about 20 percent of our total demand. With projected new weapons systems in the future, that will increase to where they are about 35 to 40 percent of our total demand.

Mr. FAZIO. That would be the peak, as you see it?

Mr. LONGENECKER. Yes, sir.

Mr. FAZIO. And what would be the work that they're doing that's going to lead us to that level? What kind of work are we going to be doing for them?

Mr. LONGENECKER. Highly enriched uranium for weapons.

Mr. VAUGHAN. As well as continuing to supply the Naval reactors.

Mr. FAZIO. But that's a pretty steady market.

Mr. VAUGHAN. That's a pretty steady market.

Mr. FAZIO. But the additional MERVing that we're doing, warheads that we'll be developing, is this based on existing authorizations or is this predicated on new military decision making?

Mr. LONGENECKER. Predicated on new authorization and appropriations.

Mr. MYERS. New ones?

Mr. LONGENECKER. Yes, sir.

Mr. FAZIO. Could you give me some idea of what those might be that would lead us to these weapons? I don't want to get into things that are classifed here, but——

Mr. VAUGHAN. I think most of what you're asking for is classified as projected in the President's Nuclear Weapon Stockpile Memorandum.

Mr. LONGENECKER. Trident and MX are two examples. Both of those use HEU——

Mr. FAZIO. Sure. That's based on how many Trident?

Mr. LONGENECKER. That's classified.

Mr. FAZIO. Yes. Well, will have a hearing that will be closed to public scrutiny next week. We have 50 MX's, though, is that correct, or are you talking about additional vehicles for testing on top of that? I mean, these are public in the sense that we voted on them on the House floor in some cases. I assume the other body did, too.

Mr. LONGENECKER. For each of those 50, however, there are different combinations of warheads and yields that would result in different future requirements on our system.

Mr. VAUGHAN. Mr. Fazio, just so there's no confusion, you refer to it as being funds in the Department of Defense budget. The budgeted funds are actually in the Defense programs portion of the Department of Energy budget.

Mr. FAZIO. Okay, thank you. But they're allocated to Defense. I mean, the overall context——

Mr. VAUGHAN. They're allocated to atomic energy defense activities.

Mr. FAZIO. But they don't come out of the DOD's budget.

Mr. VAUGHAN. No. They are in the Department of Energy's defense programs.

FORECASTING

Mr. FAZIO. Thank you. That's logical and I appreciate the clarification. I guess I didn't fully get on the record what I'd like to have for the record, and that is a greater description of where we ought to be going in terms of our forecasting in the Department in general, because I think some of what led us astray here is generic to the Department of Energy. That is not to say that anybody could have foreseen some of these extreme market occurrences.

I'm not trying to be a second guesser, but I think there were people in our society in certain areas who made the judgments that we didn't agree with for a long time. I think in my own State, when I was a member of the State legislature, we created a very controversial agency called the California Energy Commission. One of its responsibilities was to forecast energy demand, the demand for electricial generation, for example.

And I'm certainly not one of Jerry Brown's great defenders, but I was asking one of my utilities the other day, San Diego Gas and Electric, what would have happened had we allowed you to go ahead and build the Sun Desert plant. And I think uniformly the executives of that company said we'd be in deep trouble today had we built it.

We were, in effect, seeing signals from the marketplace in a regulatory context that were received, and not very happily received, by the utilities and by those who market to the utilities, which they now admit they shouldn't have overlooked. Those signals were there. It took somebody taking a very unpopular position to make them have an impact. It's that kind of foresight, it seems to me, that was lacking at the Department of Energy because, in my opinion, we had a very close and ongoing relationship with the people who, one, were committed to the technology as potential users, utilities; and two, because we had a very close relationship to the people who were purveying the technology, as suppliers.

Those factors clouded our ability to see those marketplace signals. Now, I mean, we in Congress are just as guilty of having that cloudy perspective as you are. But I guess what I think we demand from Government—because, in fact, you do have hopefully some objectivity—is a little bit more critical analysis, a little bit more willingness to see things as they are and not as some would want them to be.

I'm not saying that we're going to be right every time, but I think it was long after those messages were being sent that we received them at DOE.

Mr. LONGENECKER. Put another way, it's probably always easier to project the future by extrapolating the past.

Mr. FAZIO. Well, we were doing a lot of that.

Mr. LONGENECKER. That's led the country to a number of decisions that have proven to be wrong. We believe that no longer being a monopoly requires us be much more businesslike. We've got much better planning and marketing systems than we had before. Quite frankly, though, the job is a lot easier than it used to be, because in the United States there are only about 20 reactors now under construction.

Mr. FAZIO. Sure. It's very easy to monitor that marketplace.

Mr. LONGENECKER. Most of the ones which are under contract to us are either operating or under construction. So our job is a little easier. But if you look at our forecasting, and we do our own internal uranium enrichment forecasting, typically our estimates are lower than you'll find even within DOE and some of the other agencies. We've developed that healthy pessimism, if you will——

Mr. FAZIO. Absolutely.

Mr. LONGENECKER. Knowing that things in new plants go wrong and schedules are delayed.

Mr. FAZIO. I can see why.

URANIUM ENRICHMENT OUTLOOK

Mr. VAUGHAN. In terms of between now and the turn of the century, we've got enough capacity to produce what we believe we can sell in the uranium enrichment business, unlike the factors that were predicted to drive GCEP back when it was started. And therefore, any future decisions on AVLIS are going to need to be made first, on having it demonstrated both technically and economically, and then it has to be an economic advantage.

Mr. FAZIO. Well, I think at this point it's very easy to beat up on you, and I think you've probably benefited from some of that. But we're beyond the point now where that is appropriate and we've got to figure out where we go from here. And I'm at least satisfied in listening to you, Mr. Longenecker, that we have begun to get a handle on it belatedly.

I must say that I think it's going to be difficult to sustain this because it's unpopular and we're going to be criticized legitimately for mistakes of the past. But I know we've got to make the best we can out of a bad bargain at this point, and I hope the committee will be able to help you do that to the extent we're capable.

But one thing I share with Secretary Herrington, who was here the other day, is I think the marketplace sends very important signals, and we in Energy have to be very much more sensitive to them. That doesn't mean to say that we don't try to influence it periodically, but we have attempted to think that we were able to be exempt from it in too many instances in the past; this being a prime example.

I don't think we have any great discrepancies. I mean, people in my party were for years wanting to regulate and control, and ended up

making big mistakes with fossil fuels. And we've had people perhaps on the other side of the spectrum who were great promoters and ended up getting burned as a result. So we've all learned something, I think, about the energy markets in the last five years.

We're still learning right today as this oil price falls through the floor. But I think it ought to make us all more skeptical, not just people who end up sitting before this committee on an unhappy occasion. But all of us have to be a lot more skeptical about what we're trying to do here, because we're all too fallible. The record is replete with examples of that.

And I would hope that we won't do away with the Department of Energy and take vengeance on the Government, per se, because I think the mistakes are just as prone to be made in the private sector. It just requires all of us to understand the economics a little bit more than we have been.

Thank you, Mr. Chairman.

Mr. BEVILL. You had a question, John?

TVA POWER

Mr. MYERS. Yes, Mr. Chairman. Pursuant to the line of questioning on the TVA take or pay provisions—and I did ask some questions earlier in the testimony here today. But very briefly, could you describe is that a guaranteed dollar figure annually or kilowatt hour, or what does it provide?

Mr. LONGENECKER. We have under contract, and can call on them to supply 4,485 megawatts of electrical generation capacity. That's not dedicated to any specific power plants. Our contract with them requires them to provide and us to pay the demand charge for 4,485 megawatts of electrical capacity.

Mr. MYERS. The demand charge for that.

Mr. LONGENECKER. Yes, sir.

Mr. MYERS. Define what you mean by demand charge. What is it?

Mr. LONGENECKER. Well, I'm back to my example which you didn't like the first time, but let me try it again.

Mr. MYERS. Well, I can't imagine anybody getting into a contract if I actually understood what you described.

Mr. LONGENECKER. There's a cost of keeping the plant there; the mortgage or the capital cost of the plant.

Mr. MYERS. We call that overhead.

Mr. LONGENECKER. And that is fixed. And TVA's got to pay debt service, and they have to pay people to keep that plant in standby, theoretically, to operate. And then, when you want it to produce electricity, you've got to pay for the fuel.

Mr. MYERS. The sites.

Mr. LONGENECKER. Yes. And the fuel cost is the energy component which is $25 per megawatt hour. The demand charge, or the mere cost of keeping the capacity there, is $11. And you pay the $11 whether you're taking the electricity or not.

Mr. MYERS. They sure had a good deal, didn't they?

Mr. LONGENECKER. Well, they did. You know, you would have thought that with eight years advance notice, which we began

giving them in the early 1980's, they could have avoided some of those costs.

Mr. MYERS. Well, that's what we're interested in, that eight years notice. What you did and what they did in that eight year period.

Mr. LONGENECKER. It adds almost $4 million to each reactor's cost of fuel that we provide in 1987 to pay that demand charge. It's over $60 per SWU for each SWU that we produce in 1987 and 1988.

Mr. MYERS. And you have attempted to renegotiate that contract with them and they've—how many years does that have yet to run, that contract?

Mr. LONGENECKER. The contract expires in 1995, but the demand is down to zero in 1994. We just gave TVA the last notice to reduce our contract demand to zero in early 1994.

Mr. MYERS. If we didn't appropriate the $450 million, I wonder what they'd do.

Mr. LONGENECKER. That's a legal question.

Mr. MYERS. They'd have to negotiate then, wouldn't they?

Mr. LONGENECKER. I would suspect that they would, yes.

Mr. MYERS. Thank you. I have some more questions here pertaining to that issue. We'd appreciate your cooperation with that.

Mr. VAUGHAN. Our counsel has advised us that we're obligated to fulfill the terms of the contract.

Mr. MYERS. Where would you get the money if we didn't appropriate it?

Mr. VAUGHAN. I suspect——

Mr. MYERS. Could your counsel answer that?

Mr. VAUGHAN. I suspect we'd have to deal with that, you know, on a factual basis.

Mr. MYERS. Maybe we can negotiate for you.

Mr. VAUGHAN. We'd appreciate any help we could get, Mr. Myers.

Mr. MYERS. You see, we're in a unique situation here where we listen to both of you, the seller and the buyer. So maybe we can force the negotiations, Mr. Chairman.

Mr. BEVILL. We have other questions we'll put in the record, Mr. Secretary. And the committee will stand adjourned until 10:00 in the morning.

[The following questions and answers were provided for the record:]

PROGRAM OVERVIEW

Mr. Bevill. Mr. Secretary, by the end of 1987, 20% of all electricity generated in the United States will be produced by nuclear power plants. Do you still consider it essential to our national security to have a secure and reliable source of fuel for this power supply?

Mr. Vaughan. Yes, Mr. Bevill, I consider it essential to our national security. There are many benefits that flow from having a secure, reliable source of uranium enrichment in this country including nonproliferation benefits, substantial balance of trade benefits, energy and military security, and strengthening of the Nation's economy.

Mr. Bevill. Do you believe the Administration's proposal for the future of the enrichment enterprise is the best way to assure a long-term, viable supply of enriched nuclear fuel?

Mr. Vaughan. The Administration's proposal for uranium enrichment as described in our FY 1987 budget strikes a balance between the desire to have a healthy uranium enrichment enterprise in this country and the Administration's commitment to return the unrecovered Government investment in the enterprise to the Treasury. Given these objectives, there are a number of program alternatives that could have been proposed. We believe the options reflected in our FY 1987 budget request represents a reasonable balance between these objectives and will assure a long-term, viable enterprise.

Mr. Bevill. What, in your view, is the best way for the United States to maintain a competitive position in the domestic and worldwide uranium enrichment business?

Mr. Vaughan. In my view, I believe that the best way for the United States to maintain a competitive position in the uranium enrichment market is to assure that we can price competitively, offer reliable services, offer competitive terms, and demonstrate program stability to our customers. The optimum method for long term management of the enterprise in either the private or government sector is yet to be determined.

Mr. Bevill. What evidence can you provide the Committee to demonstrate or prove the contention that privatization of the uranium enrichment enterprise is possible, advantageous, and can be accomplished better by the private sector?

Mr. Vaughan. There are many good examples of how the private sector in the United States has deployed its resources to bring new technologies into the marketplace on a cost effective basis. Because of the significant strengths of the U.S. private sector, the Administration plans to evaluate during the next year how the strengths of the U.S. private sector can most beneficially be applied to the Uranium Enrichment program. We plan to evaluate all elements of the Uranium Enrichment program and to involve the private sector where they can strengthen the enterprise and make it more competitive for the long term.

Mr. Bevill. Mr. Longenecker, it seems that every time the uranium enrichment business gets healthy, the Administration tries to capitalize on that health for some objective other than that of keeping a healthy uranium enrichment business in this country. Now that the business is getting healthy and gaining market share, does it make sense to form a Government corporation, get more private sector involvement, and particularly get some long-term stability into the enterprise?

Mr. Longenecker. Policy stability would be a significant benefit to the enterprise and formulation of a Government corporation could contribute to meeting that goal. We will be evaluating various alternative organizational structures and options for stabilizing the uranium enrichment business and keeping it competitive for the future.

REPAYMENT OF INVESTMENT

Mr. Bevill. Describe the current proposal to require repayment of investments in the enrichment enterprise?

Mr. Vaughan. The proposal is to begin making payments to Treasury in FY 1986 and FY 1987 in the amounts of $110 million and $235 million, respectively. The Administration proposes continuing annual payments to Treasury until the $3.5 billion in enrichment investment has been recovered.

Mr. Bevill. What agreement exists between OMB and the Department concerning repayment?

Mr. Vaughan. The Administration's position concerning repayment is that: (1) the outstanding Government investment should be recovered in a manner that does not damage the Nation's uranium enrichment capability; (2) the uranium enrichment services and pricing structure should be competitive; (3) the recovery plan recognizes both the competitive nature of the international uranium enrichment market and the compelling national mandate for reduction of the Federal deficit; (4) and the recovery plan recognizes the need for institutional restructuring of the Nation's uranium enrichment services, to include private sector involvement. DOE and OMB have arrived at a common basis for analysis of the costs invested in uranium enrichment.

Mr. Bevill. Provide for the record copies of this agreement.

Mr. Vaughan. My answer to your previous question plus the proposed modifications to the Uranium Enrichment Services Criteria, published in the Federal Register on January 29, 1986, constitute the essence of the Administration's position.

Mr. Bevill. What impact would a requirement to make repayments to the Treasury have on the uranium enrichment program?

Mr. Vaughan. The FY 1987 budget submission reflects the impacts of payments to Treasury. Basically, we have made an effort to minimize outlays in each element of the program. We are minimizing production costs by sale of preproduced inventory, we have reduced expenditures for AVLIS, and we have adopted the assumption that the private sector will fund AVLIS demonstration and deployment.

Mr. Bevill. What would be the reaction of the utility industry to this proposal?

Mr. Vaughan. The utility industry has expressed some rather strong reactions concerning the initiatives of payments to Treasury and the Atomic Vapor Laser Isotope Separation (AVLIS) privatization. The utilities are expressing their concerns to the Department of Energy, DOE, directly and as a part of their comments to DOE on the proposed uranium enrichment services criteria. Specific utility concerns are that AVLIS may not be deployed on a timely basis and that DOE's prices may not be as competitive in the future as previously projected because of the proposed repayment schedule. Expressions of utility concerns are also contained in the testimony of the Edison Electric Institute before the House Science and Technology Committee, Subcommittee on Energy Research and Production on March 11, 1986.

Mr. Bevill. Is there a question of equity involved in asking current ratepayers to pay back costs incurred in prior years?

Mr. Vaughan. Since enrichment services contracts typically are for the 30-40 year life of a reactor, we don't see any basic inequity in our cost recovery methods. Further, the customers we sold enrichment services to in past years are basically the same customers we anticipate selling to in the future.

Mr. Bevill. Last year, we were told that the uranium enrichment business had $5 billion in assets and no debt. This year, the Administration is telling us that you have a $7.5 billion debt of which you will repay $3.5 billion. How did you create a $7.5 billion debt in just 1 year?

Mr. Vaughan. It is not a question of "creation" of a debt, but rather consideration of the cumulative financial effect of Government investments in this program since 1969. The $7.5 billion is the Administration's estimate of the total unrecovered Government investment in uranium enrichment as of September 30, 1985, assuming no recognition of the non-recoverable costs associated with the gaseous diffusion and gas centrifuge enrichment plants. (It should be noted that some of the unproductive investment value in the $7.5 billion total had already been "written off" in arriving at the $5 billion figure last year, just as the write off of the unproductive value of GCEP has reduced the value of unrecovered Government investment to $3.5 billion.)

Mr. Bevill. Was the $3.5 billion a politically motivated invention to help balance the budget?

Mr. Vaughan. The proposal to pay $3.5 billion to Treasury from uranium enrichment revenues was influenced by our concern with repaying the unrecovered Government investment in the enterprise.

Mr. Bevill. Does the Administration recognize that payments to Treasury have not been authorized by Congress and therefore are illegal?

Mr. Vaughan. Section 161v of the Atomic Energy Act states that the charge for enrichment services shall recover the Government's costs of providing enrichment services over a reasonable period of time. The application of revenues received from the sale of enrichment services is determined in annual appropriation acts. The Administration has proposed as a part of its FY 1987 budget request that $235 million of enrichment revenues be used to make payments to the Treasury.

Mr. Bevill. If you were to reduce the amount that is paid to Treasury to say $100 million per year, couldn't you fund a very healthy AVLIS program to have AVLIS ready when needed?

Mr. Vaughan. If the amount specified for payments to Treasury were reduced, then additional resources would be available to develop AVLIS on a more aggressive schedule. However, we believe that the $50 million budget does not remove the possibility of having a competitive AVLIS technology available when needed to assure U.S. price competitiveness.

Mr. Bevill. How can the Department maintain that it is trying to promote nuclear power in the United States and at the same time, add a $3.5 billion surcharge to the cost of nuclear fuel over the next 15 years?

Mr. Vaughan. The $3.5 billion reflects the Administration's estimate of the total outstanding Government investment in the uranium enrichment enterprise. The Administration's proposal to return these funds to the Treasury reflects a balance between the objective of maintaining a competitive U.S. enrichment industry and the desire to return to the Treasury the unrecovered Government investment in the enterprise.

Mr. Bevill. Isn't the process of payments to Treasury really a selling off of your assets? Doesn't it essentially mean that you are going out of the business as your asset value approaches zero?

Mr. Vaughan. The proposed payments to the Treasury reflect a planned recovery of the existing Government's investment in the uranium enrichment enterprise. The proposal assumes that all new enrichment investments will be made by the private sector and that the Government's asset value will be reduced as inventories are sold and as the gaseous diffusion plants are depreciated.

Mr. Bevill. Did GAO say in its August 1984 report that there was no requirement nor legal authority for the Department to make payments to Treasury? Provide for the record GAO statements on repayment.

Mr. Vaughan. On August 10, 1984, GAO issued a report to the Chairman of the House Committee on Energy and Commerce entitled "Information on Repayment of the Government's Uranium Enrichment Program Costs and Audits of That Program's Financial Statements". On page 8 of that report, GAO states:

> "DOE is not required to have a formal plan for repaying the Treasury for the Government's cost of providing uranium enrichment services, nor does the legislative history indicate that the Congress intended the program to make specific repayments to the Treasury as is the case for some other programs. DOE is, however, required by the Atomic Energy Act of 1954, as amended, to recover the Government's costs of providing enrichment services. These recovered costs have not been used by DOE to repay the Treasury but, as explained in the answer to the previous question, have been designated by the Congress either for use as part of actual appropriations or to offset appropriations. Therefore, the specific use of the revenues has been governed by language contained in appropriations acts and not left to the discretion of program or agency officials."

I will provide the GAO correspondence relating to repayment as an insert to the record.

(The information follows:)

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

B-207463 December 27, 1984

The Honorable John D. Dingell
Chairman, Committee on Energy
and Commerce
House of Representatives

Dear Mr. Chairman:

This is in response to your joint request of May 11, 1984, along with Chairman Richard L. Ottinger, Subcommittee on Energy Conservation and Power, House Committee on Energy and Commerce, for our opinion on several questions related to the Department of Energy's (Energy) new Utility Services Contract for uranium enrichment services. Specifically, you asked:

1. What obligations have been and will be incurred by the Government as a result of the issuance of the Utility Services Contract and by any further execution of the contract?

2. What is the legality and propriety of the Department's actions with regard to the unilateral establishment of a ceiling price and implementation of accounting changes?

3. Is it within generally accepted accounting principles and/or the statutory requirements governing this program to:

(a) "write off" approximately $1.2 billion of Government investment in enrichment equipment, and

(b) to defer the recapture of depreciation expenses to an unspecified future date?

In addition, you subsequently informally asked that we include in our discussion (1) Energy's revaluation of its uranium feed stock from market price to acquisition cost and (2) whether any of Energy's foregoing actions were subject to the provisions of the Administrative Procedure Act.

We requested Energy's comments on these questions, and have taken their responses into consideration in formulating our answers.

After carefully researching and analyzing the issues you posed, we have very serious concerns about the actions Energy has taken associated with its new Utility Services Contract, both substantively and procedurally. Before providing the results of our research and analysis, it is important to set

in perspective the fundamental problems which have developed over the last several years for the uranium enrichment program. The market environment in which Energy's program must operate today is considerably different from the one which existed in the early 1970s when the Congress provided that the Government's prices for enrichment services be based on recovering the program's full cost.

The lower prospects for growth in the nuclear power industry coupled with foreign competition and the emergence of a secondary market for enriched uranium are all affecting the program. U.S. prices in the past few years have been the highest in the world, and the program's competitive position has been steadily deteriorating. Because of these conditions, we have stressed in past testimony before the Congress, including the Subcommittee on Energy Conservation and Power, the need for the executive branch and the Congress to reexamine the fundamental purpose and structure of the uranium enrichment program. We suggested that such a reexamination must consider our nation's objectives for serving the domestic and international uranium enrichment markets and provide adequate flexibility in pricing policies to allow effective competition with foreign suppliers.

In summary, we find that Energy's actions with regard to the new Utility Services Contract were not in compliance with applicable statutory principles; specifically, the Administrative Procedure Act, 5 U.S.C. § 551 et seq., the Department of Energy Organization Act, 42 U.S.C. § 7191(b)(3), and the Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2201(v).

In addition, while accounting changes made by Energy to reduce the reported cost of enriching uranium are generally in accordance with published Generally Accepted Accounting Principles (GAAP), the reduced price arrived at as a result of the changes would violate the Atomic Energy Act's provision requiring cost recovery for the uranium enrichment program.

Background

Uranium enrichment is a process used to increase the concentration of the fissionable uranium-235 isotope found in natural uranium to the levels required for the uranium to be used in various applications. Since 1969, the Federal Government--through the former Atomic Energy Commission, the former Energy Research and Development Administration, and now Energy--has operated enrichment plants primarily to enrich customer-owned uranium for use as a fuel in domestic and foreign nuclear power reactors. Energy's plants also provide enriched uranium for research and defense applications.

At first, the United States basically had a monopoly in the enriched uranium market. Beginning in the mid-1970's, competition developed as two European consortia and the Soviet Union began supplying enrichment services. Competition from foreign suppliers reduced Energy's share of the foreign market from 100 percent in the mid-1970's to its current level of about 35 percent. Coupled with this new competition was a downturn in the prospects of the domestic nuclear power industry as a result of reduced consumer demand for electricity and concern over nuclear proliferation, health and safety issues. As a result, many nuclear power plants were delayed or cancelled. 1/

By the late 1970's, both foreign and domestic utilities found themselves committed to long-term contracts for enrichment services they no longer needed. According to Energy's estimates, a worldwide surplus of about 39 million separative work units (SWU's) now exists, which represents nearly four times Energy's total enrichment production during fiscal year 1983. This, in turn, had led to the emergence of a secondary market for enriched uranium selling at discounted prices.

Throughout this period Energy has been statutorily required to break even on its uranium enrichment activities--that is, to recover its costs over a reasonable period of time but not to make a profit. 42 U.S.C. § 2201(v). Changing world market conditions have made this increasingly more difficult. During the 1980's Energy's prices for enrichment services have generally been the highest in the world--$138.65 to $149.85 per separative work unit (SWU). Foreign suppliers reportedly are providing comparable services at prices ranging from $100 to $117 per SWU, and prices on the secondary market have been as low as $90 per SWU.

Energy has advised us that its most pressing needs were to stabilize the Department's market share, provide for an orderly reduction of excess world inventories of enriched uranium, and control program expenditures to match anticipated revenues. One of the steps Energy took to meet these objectives was the new Utility Services Contract.

1/ For elaboration of information in this and the succeeding two paragraphs, see Information on DOE's Costing and Pricing of Uranium Enrichment Services, GAO/RCED-84-156, April 25, 1984, and Lost DOE Sales to the Secondary Enriched Uranium Market Have Resulted in Reduced Revenues, GAO/RCED-84-76, January 26, 1984.

You informally indicated that in response to question 1 you wanted an articulation of the major features of the new contract. Energy lists the major features of the contract as:2/

1. Permitting the customer the flexibility to purchase between 70 and 100 percent of its annual enrichment "requirements" from Energy and up to 30 percent of its needs from other sources;

2. Providing a reduced leadtime to firm up delivery quantities (180 days in advance of delivery as opposed to 6 years);

3. Increasing the period of time required for notice by the customer to Energy for termination without penalty;

4. Providing the customer the flexibility to select the tails assay within a given range; and

5. Providing price protection to the customer in the form of a guaranteed long-term price ceiling.

Energy offered the new Utility Services Contract to customers on January 18, 1984. As of November 6, 1984, 44 of Energy's 51 domestic customers had converted to the new contract, and 28 of Energy's 35 foreign customers had converted.

The basic issue involved in your other questions is whether Energy's actions associated with the new Utility Services Contract were in compliance with the statutory constraints under which Energy must operate the uranium enrichment program.

Propriety of Energy's Unilateral Actions

In providing enrichment services to its customers, Energy is required under subsection 161(v) of the Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2201(v), to price its services so that the Government's enrichment costs will be recovered over a reasonable period of time. In addition, the same statutory provision requires Energy to establish criteria

2/ Energy's description of the purpose and anticipated impact of each major feature is included as Appendix I to this letter opinion.

setting forth the terms and conditions under which enrichment services will be available, and requires Energy to submit the criteria, and any changes therein, to the appropriate congressional authorizing committees for a 45-day review period prior to their taking effect. See also, H.R. Rep. No. 1702, 88th Cong., 2d Sess. 31 (1964); S. Rep. No. 1325, 88th Cong., 2d Sess. 31 (1964). Of course, the criteria must be in accord with the statutory requirements of the program, and the enrichment contracts must be in accord with the statute and criteria.

In addition, subsection 501(b)(3) of the Department of Energy Organization Act, 42 U.S.C. § 7191(b)(3), renders Energy's rules, regulations or orders with respect to public property, loans, grants, or contracts, subject to the administrative procedures set forth in the Administrative Procedure Act, 5 U.S.C. §§ 551 et seq., and subsection 501 of the Department of Energy Organization Act, 42 U.S.C. § 7191.

Before issuing its new Utility Services Contract, Energy did not make any amendments to its uranium enrichment service criteria, and consequently made no provision for the 45-day review period before the appropriate congressional authorizing committees. In addition, Energy made no attempt to comply with the administrative procedures prescribed in the Administrative Procedure Act, supra, or the Department of Energy Organization Act, supra, regarding any aspect of its Utility Services Contract. Energy asserts that neither the development of the new contract, the pricing provisions nor the accounting principles associated with the Utility Services Contract required amendments to the criteria or compliance with these statutory administrative procedures. Moreover, Energy asserted that the Utility Services Contracts are more akin to customer-tailored individual applications resulting from customer-specific negotiations rather than contracts of general application. In essence, therefore, Energy's actions regarding the Utility Services Contract were taken unilaterally, save consultation with its utility customers, and did not formally involve the Congress or other affected parties, such as the uranium mining and processing industries, public interest groups, utility rate payers, the taxpaying general public, etc.

In our view, Energy did not follow prescribed statutory requirements by acting unilaterally regarding its Utility Services Contract, in light of the provisions of the Atomic Energy Act, supra, and the Department of Energy Organization Act, supra.

Criteria

Subsection 161(v) of the Atomic Energy Act of 1954, as amended, supra, provides that Energy "shall establish criteria in writing setting forth the terms and conditions under which services provided under this subsection shall be made available." (Emphasis added.) "Included among these 'terms and conditions' would be such matters as the charges for enrichment services, the conditions under which such services would be offered, and the general features of standard contracts for uranium enrichment services." (Emphasis added.) H.R. Rep. No. 1702, 88th Cong., 2d Sess. 16 (1964); S. Rep. No. 1325, 88th Cong., 2d Sess. 16 (1964). Thus the criteria are to include the general features of standard contracts for uranium enrichment services.

The current uranium enrichment services criteria appear at 44 Federal Register 28875 (May 17, 1979). They include many guidelines on contract features in general terms, which must or may be included in Energy's uranium enrichment contracts in more detail. Examples are provisions concerning advance contracting, fixed commitments, advance payments, delivery schedules, chemical form and specifications of feed material, the basis on which charges for enriching services will be calculated, a customer option to acquire tails material, termination by either Energy or the customer, delivery, transfer of title, and others.

However, the Utility Services Contract contains provisions that either conflict with or are not specifically authorized by the existing uranium enrichment services criteria. For example, the existing criteria provide that "The primary contracting vehicle for DOE [Energy] to supply enriching services for nuclear power reactors on a long-term basis shall be a Fixed Commitment Contract." 44 F.R. 28875, 28876 (May 17, 1979). Yet in testimony before congressional committees Energy has repeatedly referred to the Utility Services Contract as a requirements-type contract.3/ The current criteria also provide that "Termination charges per kg unit of separative work will be established on a basis of recovery of the costs which the DOE [Energy] estimates may arise from terminations by customers." Id., at 28877. Yet we see no

3/ See, e.g, Testimony of Mr. Shelby T. Brewer, Assistant Secretary for Nuclear Energy, Energy and Water Development Appropriations for 1985, Part 6, Hearings Before the Subcommittee on Energy and Water Development, House Committee on Appropriations 901, 907, 916 and 994 (March 19, 1984).

evident relationship between Energy's costs upon customer termination and the penalties assessed customers for termination in the Utility Services Contract. Rather termination penalties under the Utility Services Contract seem to be dependent on the period of notice that the customer has given Energy prior to termination. For example, with 10 years notice the customer is assessed no penalty; with 9 years notice, a 10 percent penalty; with 8 years notice, a 20 percent penalty; with 7 years notice, a 30 percent, etc.; down to with less than 1 year notice, a 100 percent penalty. This appears to be a simple mathematical computation unrelated to actual costs incurred by Energy, but which acts as a deterrent to termination on short notice. In addition, the existing criteria make no specific provision for a customer Variable Tails Assay Option or a guaranteed ceiling price, both of which are contained in the Utility Services Contract.

You express particular concern about the guaranteed ceiling price. The guaranteed ceiling price provision in the Utility Services Contract is a guarantee by Energy to its customers that it will not charge a price higher than $135 per SWU for the next 10 years, 4/ and that Energy will not increase its price above this maximum without 10 years advance notice to its customers. These are coupled with a customer's right to cancel its long-term contract with Energy without any termination penalty if 10 years advance notice of cancellation is provided to Energy. The net effect is that with timely notice a customer can cancel out without penalty any time Energy raises its ceiling price, and Energy is locked into the $135/SWU ceiling price for at least the next 10 years.

A guaranteed ceiling price is a very material provision of a contract, particularly when the ceiling price appears to be below Energy's current costs of providing enrichment services and Energy's program statute requires recovery of its costs over a reasonable period of time. Energy itself recognizes its importance by advising us that if the provision were struck down, Energy would renegotiate all of the Utility Services Contracts and reexamine its whole program. Yet we did not find and Energy does not claim that the uranium enrichment services criteria contain any provision specifically authorizing guaranteed ceiling prices. Rather, Energy, without pointing to any specific language in the criteria that might cover a guaranteed ceiling price, seems to rely on the purpose of the Atomic Energy Commission's (AEC) criteria modifications in

4/ The contract does provide for adjustment of the ceiling price but only to reflect changes in Energy's unit costs for electricity and the purchasing power of the dollar.

1973, namely, to provide greater flexibility, as justification for permitting new contract provisions without amending the criteria. We find Energy's argument troubling as a general matter, and particularly unpersuasive regarding a guaranteed ceiling price.

It is accurate that in 1973 the AEC, a predecessor agency of Energy, did attempt to make the uranium enrichment services criteria contain more general, generic terms and conditions than had been in the earlier criteria. However, the AEC's effort was largely unsuccessful. Our analysis of the events in 1973 supports neither a conclusion that Energy has unrestricted flexibility in what it places in its enrichment contracts nor that Energy can bypass amending its criteria before including a new feature in its contracts, particularly a guaranteed ceiling price.5/

In 1966 when the first uranium enrichment services criteria were established, they specifically provided for a guaranteed ceiling price. 31 F.R. 16479, 16480 (December 23, 1966). On the initiative of the AEC, this guaranteed ceiling price provision was purposely deleted by the 1973 amendments to the uranium enrichment services criteria. The AEC's rationale was that a guaranteed ceiling charge could preclude compliance with the statutory directive to recover the Government's costs over a reasonable period of time should the Government have to undertake the construction of additional enrichment capacity.6/

Now some 11 years later, the AEC's successor agency claims those criteria permit a guaranteed ceiling price, without pointing to any specific section of the criteria to support its position. Since there have been no relevant changes to the criteria in the intervening 11 years, we find Energy's position unpersuasive. Moreover, the concern which prompted the AEC to delete the guaranteed ceiling price provisions from the criteria in 1973 is still applicable today, namely, the fear that a guaranteed ceiling price could preclude compliance

5/ A more comprehensive review of our analysis of the legislative history of the 1973 amendments to the uranium enrichment services criteria appears as Appendix II.

6/ Proposed Changes in AEC Contract Arrangements for Uranium Enriching Services, Hearings Before the Subcommittee on Energy, Joint Committee on Atomic Energy, 93rd Cong., 1st Sess. 446 (March 7, 8, 26; and April 18, 1973).

with both the statutory and criteria directive to recover the Government's costs over a reasonable period of time. This is particularly of concern in a competitive international uranium enrichment market and while the Government is undertaking the construction of additional enrichment capacity.

Energy also asserts that in several instances over the past years, it and its predecessors have made changes in pricing methodology without amending the uranium enrichment services criteria. They state that these changes all had a significant impact on the definition of costs, were consistent with the criteria, were not considered to be "general features" required to be in the criteria and were made known to Congress after the price which reflected the change was announced. However, we find that each of these actions would have been covered within the specific terms of the existing criteria, and accordingly cannot be considered valid precedents for Energy's current actions.

In summary, we conclude that Energy should have amended its uranium enrichment services criteria to conform them to the anticipated provisions of the Utility Services Contract, because the new contract includes provisions that either conflict with or are not specifically authorized by the current criteria.

Administrative Procedures

We recognize that in the past uranium enrichment contracts and prices have been governed by the procedures set forth in subsection 161(v) of the Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2201(v), discussed above. However, with the enactment of the Department of Energy Organization Act (Organization Act), 42 U.S.C. § 7101 et seq., in 1977, additional requirements are applicable to the program. Subsection 501(a)(1) of the Organization Act, 42 U.S.C. § 7191 (a)(1), provides that the provisions of the Administrative Procedure Act (APA), 5 U.S.C. § 551 et seq., apply to rules, regulations or orders associated with programs transferred to the Secretary of Energy by the Act. This would include the uranium enrichment program. This requirement is over and above that contained in subsection 161(v) of the Atomic Energy Act of 1954, as amended, supra.

Ordinarily "matter relating to agency management or personnel or to public property, loans, grants, benefits, or contracts" would be exempt from APA procedures by virtue of 5 U.S.C. § 553 (a)(2). These categories would likely encompass many aspects of the uranium enrichment program, and thus

exempt them from APA procedures. However, subsection 501(b)(3) of the Organization Act, 42 U.S.C. § 7191(b)(3), states:

> "For the purposes of this Act, the exception from the requirements of section 553 of Title 5 provided by subsection (a)(2) of such section with respect to public property, loans, grants, or contracts shall not be available."

Accordingly, at least some aspects of the uranium enrichment program are now subject to the procedures prescribed in the APA that had not been covered by those procedures prior to 1977.1/

Moreover, for those elements subject to the APA, subsections 501(b) and (c) of the Organization Act, 42 U.S.C. §§ 7191(b) and (c), also set forth applicable procedures, some of which are duplicative of the APA but others of which are more stringent than the APA. These subsections provide, in part:

> "(b)(1) * * * notice of any proposed rule, regulation, or order * * * shall be given by publication of such proposed rule, regulation, or order in the Federal Register. Such publication shall be accompanied by a statement of the research, analysis, and other available information in support of, the need for, and probable effect of, any such proposed rule, regulation, or order. Other effective means of publicity shall be utilized as may be reasonably calculated to notify concerned or affected persons of the nature and probable effect of any such proposed rule, regulation, or order. In each case, a minimum of thirty days following such publication shall be provided for an opportunity to comment prior to promulgation of any such rule, regulation, or order.
>
> * * * * *

1/ We acknowledge that the uranium enrichment services criteria and amendments thereto prior to 1977 clearly are not affected by virtue of the savings provision in subsection 705(a) of the Organization Act, 42 U.S.C. § 7295(a).

"(c)(1) * * * If the Secretary determines that a substantial issue of fact or law exists or that such rule, regulation, or order is likely to have a substantial impact on the Nation's economy or large numbers of individuals or businesses, an opportunity for oral presentation of views, data, and arguments shall be provided.

"(2) Any person, who would be adversely affected by the implementation of any proposed rule, regulation, or order who desires an opportunity for oral presentation of views, data, and arguments, may submit material supporting the existence of such substantial issues or such impact.

"(3) A transcript shall be kept of any oral presentation with respect to a rule, regulation, or order * * *."

Based on the definition of a rule contained in 5 U.S.C. § 551(4), the aspects of the uranium enrichment program that could be potentially affected by these administrative procedures, and which were involved in the circumstances surrounding Energy's actions regarding the Utility Services Contract, include:

(1) the issuance of a new, generic type of contract for uranium enrichment services;

(2) any amendment to or modification of the uranium enrichment services criteria;

(3) any price change for uranium enrichment services; and

(4) accounting changes that affect the prices charged for uranium enrichment services.

A court may ultimately have to determine to which elements of the uranium enrichment program, and to what extent, the procedures prescribed in the APA and the Organization Act apply. However, there is little doubt that these procedures are applicable to at least some of the elements of the uranium enrichment program. Accordingly, Energy was ill-advised to unilaterally go forward with the Utility Services Contract and associated events without a careful and considered analysis of these matters. We have no indication that they did so. Moreover, we have been advised that a law suit was filed on

December 7, 1984, in the Federal District Court for the District of Colorado, Western Nuclear, Inc. et al v. Huffman et al., Civil Action No. 84C-2350, based at least in part on Energy's failure to comply with these procedures in relation to the circumstances surrounding the Utility Services Contract.

GAO's Concern

Aside from the strictly legal view of these issues, GAO is concerned that Energy's unilateral actions in offering the Utility Services Contract deprived the Congress and other affected parties (such as the uranium mining and processing industries, public interest groups, utility rate payers, the taxpaying general public, etc.) from meaningful participation in the decisionmaking process. Important policy issues were involved affecting the operation and financial commitments to the program for many years into the future. Congress should have been fully informed about them and been involved in determining the policy direction that the program takes. In addition, all affected segments of the industry, as well as interested parties from the public, should have had an appropriate opportunity to participate in the process.

Accounting Changes

Energy set the dollar amount of the guaranteed ceiling price in its new Utility Services Contract with an eye to market conditions and the prices of its competitors rather than on the basis of cost recovery. In fact, the ceiling price, $135/SWU, is both lower than the price that had been charged under prior contracts and lower than current costs when calculated as Energy has traditionally calculated them. In an attempt to achieve this low price and remain in compliance with the statutory requirement that Energy recover its costs from the uranium enrichment program, Energy has planned two significant accounting modifications for pricing purposes, after consultation with a public accounting firm. The first is a write-off for both financial statement and pricing purposes of $1.2 billion of certain portions of its undepreciated plant and capital equipment. The second is the revaluation for pricing purposes of its uranium feed stockpile from market price (approximately $40 per pound) 8/ to acquisition cost (approximately $9 per pound).

8/ Energy estimated that the current average market price was about $40 per pound. This average includes a low of about $17 per pound for uranium which is offered on the spot market. We made no independent review to verify this estimate.

You asked whether these accounting modifications were (1) in accordance with Generally Accepted Accounting Principles, and (2) permissible under the statutory requirements governing the program.9/

While the write-off of a portion of Energy's undepreciated plant and capital equipment attributable to unused capacity is in accordance with Generally Accepted Accounting Principles, the proportion used by Energy is not. Moreover, such action is not in accord with the statutory mandate of subsection 161(v) of the Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2201(v), requiring cost recovery for Energy's uranium enrichment program. Therefore, we conclude that the write-off would constitute a violation of the statute.

Background

Energy's existing uranium enrichment capability consists of three plants, located at Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio. These plants use an enrichment process known as gaseous diffusion. They were originally built in the 1940's and 1950's to satisfy military needs. Many military requirements, however, were satisfied through the accumulation of stockpiles of enriched uranium. With the development of the civilian use of nuclear power, the uranium enrichment program has been increasingly operated for the benefit of civilian customers.

In the beginning the Government was the sole source of enriching services to its civilian customers and the sole owner of nuclear materials in light of proliferation implications. Enriched uranium was leased to customers. This changed as a result of the enactment of the Private Ownership of Special Nuclear Materials Act, Pub. L. No. 88-489, approved August 26, 1964, 78 Stat. 603. Beginning in 1969, that act authorized toll enrichment, under which the AEC (now Energy) provides a service by enriching privately-owned uranium for a fee based on the amount of separative work required. In conjunction with this change to the civilian nuclear market, the three gaseous diffusion plants and the stockpile of uranium feed were transferred to what is now known as the uranium enrichment program.

9/ You had also requested that we address the propriety of deferring the recovery of depreciation to an unspecified future date. Energy reported to us, in part, that deferral "is not the most appropriate accounting treatment for this particular set of circumstances." Since Energy is no longer proposing the deferral of these expenses, we will not address this issue.

The Government is required to recover its costs for the uranium enrichment program over a reasonable period of time. 42 U.S.C. § 2201(v). The unit price for separative work is to be calculated to satisfy the statutory mandate. The program's costs include, among many other things, the depreciation on plant and capital equipment and the value of Government uranium feed used, if any.

The undepreciated balance on the original three gaseous diffusion plants as of fiscal year 1971 10/ was approximately $1 billion, and $700 million of this had already been recovered from customers by fiscal year 1983 as a part of their toll enrichment fees. Rather than the original costs, however, the primary unrecovered depreciation associated with these three plants stems from plant modifications undertaken in the 1970's to increase their efficiency and capacity, specifically to benefit civilian customers. The original plants have been improved (Cascade Improvement Program or CIP) and uprated (Cascade Uprating Program or CUP) at a cost of over $1.5 billion.11/

These three gaseous diffusion plants have operated at or less than 41 percent of production capacity since and including 1980, because of competitive conditions in the world uranium enrichment market. However, Energy used about 74 percent of its uranium enrichment plant and equipment to operate at 40 percent of production capacity. Energy expects to continue to operate these gaseous diffusion plants at this or lower levels in the future. Consequently, in its fiscal year 1984 financial statements Energy plans to write off 60 percent of the book value of the plant and capital equipment associated with these three gaseous diffusion plants or approximately $1.2 billion. Our understanding is that this program cost has been already excluded from the pricing formula used to calculate the $135/SWU ceiling price. Therefore, it will not be recovered from program customers, but will be considered a sunk cost to be borne by the taxpayers.

In addition, Energy is now building another enrichment plant at Portsmouth, Ohio (GCEP) and is developing two advanced technologies--Atomic Vapor Laser Isotope Separation and Advanced Gas Centrifuge. Energy plans to use one of the advanced technologies to replace some diffusion plant

10/ Annual financial statements have been prepared for the uranium enrichment program only since fiscal year 1971.

11/ Information in this paragraph was obtained from Information on Repayment of the Government's Uranium Enrichment Program Costs and Audits of that Program's Financial Statements, GAO/RCED-84-190, August 10, 1984.

capacity. When this occurs, an additional large write-off of the book value of one or more of the gaseous diffusion plants may be expected. In addition, if the Atomic Vapor Laser Isotope Separation technology is ultimately chosen as the replacement technology over the Advanced Gas Centrifuge, Energy may need to write-off the $2.1 billion already spent on the GCEP facility.

Generally Accepted Accounting Principles and Pricing

Generally Accepted Accounting Principles (GAAP) set forth reporting requirements for external, general purpose, financial statements. While financial statements in accord with GAAP can provide information for pricing decisions, GAAP do not provide the rules or specific guidance governing the pricing of goods and services. The recovery of depreciation is a pricing issue and is, in this instance, not governed by GAAP. Energy's pricing guidance emanates from the Atomic Energy Act of 1954, as amended, its legislative history and history of implementation.

In the context in which the issue is posed here, there are indeed two separate questions. Moreover, the question of whether or not GAAP allows Energy to report on its financial statements an accounting adjustment writing-off significant portions of its plant and equipment is probably not relevant to whether or not Energy violates a congressional mandate when it establishes a price which does not recover the cost of the Government's investment in uranium enrichment facilities. In the context here, the latter is the more important of the two. Thus, if Energy's program statute requires full cost recovery of the Government's investment, Energy cannot use a financial statement adjustment to justify excluding these costs from its pricing formula. That is what we ultimately conclude. Accordingly, the following discussion of GAAP and the write-off describes only what may be permissible without consideration of statutory pricing constraints.

GAAP and the Write-Off

Generally Accepted Accounting Principles currently give no specific guidance for accounting for the inability to fully recover the carrying amounts of long-lived assets. While the Accounting Standards Executive Committee, an advisory board of the American Institute of Certified Public Accountants (AICPA), did conclude that the inability to fully recover the carrying amounts of long-lived assets should be reported in the financial statements, it did not specify criteria for determining whether or not an unrecoverable decline in asset value had occurred or the amount of the decline. Since no

specific criteria exist, one must decide whether or not a write-down of a long-lived asset is appropriate based upon the circumstances of each case. According to the AICPA, some possible indicators of an inability to fully recover carrying amounts of long-lived assets that one should consider are:

--a reduction in the extent to which a plant is used,

--a dramatic change in the manner in which an asset is used,

--a substantial drop in the market value of an asset,

--a change in law or environment,

--a forecast showing lack of long-term profitability, and

--costs in excess of the amount originally expected to acquire or construct an asset.

While Generally Accepted Accounting Principles allow write-downs of long-lived assets to recoverable value, the literature is presently being interpreted to permit or require write-downs of long-lived assets only in rare situations. The asset write-down must result from clear indications of permanent impairment of asset value. Otherwise, write-downs of long-lived assets might be used to achieve objectives other than adhering to Generally Accepted Accounting Principles.

Applying only the GAAP, in our opinion, the Department of Energy could recognize (report) the inability to fully recover the carrying value of its uranium enrichment plants. Two of the indicators of the inability to fully recover the carrying amounts of long-lived assets, noted previously, apply. First, two changes in the environment, an overall decline in the growth of nuclear power, and new foreign competition, occurred in the past decade. Secondly, in fiscal year 1983, Energy used 74 percent of its uranium enrichment plant and equipment to operate at about 40 percent of production capacity. Moreover, Energy expects its plants to continue to operate at this or lower levels in the future.

However, while we agree that the Department under GAAP may write-down the carrying value of its uranium enrichment plants for financial statement purposes, we do not agree with Energy's measurement of the value of its uranium enrichment plants. Based upon its plants operating at 40 percent of

production capacity, Energy believes it should write-down the carrying value of its uranium enrichment plant and equipment by 60 percent. In our opinion, the percentage of plant and equipment in use, 74, rather than the percentage of production capacity, 40, should serve as the measurement of asset value. Thus, assuming a continuing 74 percent use of plant and equipment, Energy's write-down of its plant and equipment should more appropriately be 26 percent rather than 60 percent. Additionally, the adjustment must be reported as an unusual or infrequent item (not an extraordinary item) on the program's income statement. It cannot be made directly to the equity accounts without having been reported on the income (profit and loss) statement.

Reporting the write-off in the income statement defeats Energy's pricing objective of keeping costs within the $135/SWU ceiling price. When Energy calculates its prices, it includes any profits or losses that have accumulated through the end of the preceding year in its pricing formula. Because the $1.2 billion write-off, under GAAP, should be reported in the income statement, it would result in a significant program loss. This loss in turn should be included in any future pricing calculations, and would increase the price above the $135/SWU ceiling, thus defeating Energy's motivation for writing-off these unrecovered costs.

In addition, under GAAP Energy should revise the estimated useful service life of its uranium enrichment gaseous diffusion plants to better conform to management intent and environmental conditions. When an originally selected useful life for an asset turns out to be sufficiently incorrect that future years' reported income will be materially misstated, GAAP requires that an entity correct the useful life and spread the book value remaining at the date of change over the remaining revised useful life. If such an adjustment is not made, the introduction of advanced enrichment technologies will make existing gaseous diffusion plants obsolete before they are fully depreciated. And, Energy will again face large write-offs of the undepreciated asset base.

Moreover, should Energy close any of its three gaseous diffusion plants, the Department must recognize the cost of the plant closing by writing-off the remaining value of the closing plant's facilities and recognize any remaining contractual liabilities in a manner consistent with generally accepted methods for reporting discontinued operations. In addition, Energy should then recognize the costs necessary to dismantle and decontaminate the closing plant, and should begin now serious consideration of whether and how these costs should be included in the program's rate base and pricing formula to be recovered from customers.

In summary, therefore, on the central issue we conclude that GAAP allows Energy to report on its financial statements an accounting adjustment writing-off the portions of its plant and equipment attributable to unused capacity not expected to be used in the future. However, the write-down more appropriately should be 26 percent, representing the percentage of plant and equipment not used, rather than 60 percent, representing the percentage of unused production capacity. In addition, under GAAP the adjustment cannot be made directly to the equity accounts without having been reported on the income statement. Moreover, Energy cannot use a financial statement adjustment to justify excluding these costs from its pricing formula.

Pricing Constraints

Subsection 161(v) of the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2201(v), governing the toll uranium enrichment program, provides, in part, that prices for the program "shall be on a basis of recovery of the Government's costs over a reasonable period of time." In addition, subsection 4(c) of the existing uranium enrichment services criteria, implementing the statute, provides, in part:

"Charges for enriching services --

"(1) The charges for enriching services, in accordance with the Act, will be established on a nondiscriminatory basis and on a basis of recovery of the Government's costs over a reasonable period of time. * * *

"(2) DOE's charges for enriching services will be established on a basis that will assure the recovery of appropriate Government costs projected over a reasonable period of time. The cost of separative work includes electric power and all other costs, direct and indirect, of operating the enrichment plants; appropriate depreciation of said plants; and a factor to cover applicable costs of process development, DOE administration and other Government support functions, and imputed interest on investment in plant, working capital, and natural uranium contained in those inventories at the DOE enrichment plants needed to provide enrichment services. During the early period of growth of nuclear power, there will be only a small

> civilian demand on the large DOE enrichment plants. These plants were originally constructed for national security purposes, but will be utilized in meeting future civilian requirements. In this interim period of low plant utilization, the DOE has determined that the costs to be charged to the separative work produced for civilian customers will exclude those portions of the costs attributable to depreciation and interest on plant investment which are properly allocable to plant in standby and to excess capacity." (Emphasis added.) 44 Fed. Reg. 28876, 28877 (May 17, 1979).

Energy considers that the writing-off of approximately $1.2 billion of unused capacity of its gaseous diffusion plants, so as not to require customer payment of its depreciation, is consistent with the cost recovery requirements of subsection 161(v) of the Atomic Energy Act of 1954, as amended, supra, and the quoted portions of the uranium enrichment services criteria. 12/ Energy lists as evidence of flexibility in the requirements (1) the use of the phrases "appropriate Government costs" and "appropriate depreciation of said plants," and (2) the example of the recovery of less than full depreciation during the interim period of early nuclear power growth.

We disagree with Energy. We believe these provisions cannot properly be interpreted in the abstract. The purpose, the subject matter, the context, and the legislative history, as well as the executive interpretation, are aids to be considered in construing a statute. United States v. Cooper, 312 U.S. 600, 61 S. Ct. 742 (1941). While the interpretation given a statute by those charged with its application and enforcement is entitled to considerable weight, it hardly is conclusive. Marin County v. United States, 356 U.S. 412, 78 S. Ct. 880 (1959). And we acknowledge that when the construction of an administrative regulation, rather than a statute is in issue, deference is even more clearly in order. Udall v. Tallman, 380 U.S. 1, 85 S. Ct. 792 (1965). Nevertheless, the persuasiveness of an administrative interpretation is dependent on the thoroughness evident in its consideration, the

12/ Energy also asserts that no amendments to the uranium enrichment services criteria were required. We do not address this issue here, because we agree with Energy that a criteria change was not needed. We too believe the language of the criteria is sufficiently flexible to encompass Energy's actions, if permissible under the statute.

validity of its reasoning, its consistency with earlier and later pronouncements, and all those factors which give it power to persuade. Skidmore v. Swift & Co., 323 U.S. 134, 65 S. Ct. 161 (1944); Case & Co., Inc. v. Board of Trade of City of Chicago, 523 F.2d 355 (7th Cir. 1975).

After careful analysis of the statute and the criteria in this light, 13/ we cannot legally support Energy's position. We conclude that a write-off for pricing purposes of undepreciated plant and capital equipment, so as to obviate the need for customer payments of related depreciation as part of the fee for enriching services, violates the statutory mandate of subsection 161(v) of the Atomic Energy Act of 1954, as amended, supra, requiring cost recovery for Energy's uranium enrichment program.

When the toll enrichment program was first authorized in the Private Ownership of Special Nuclear Materials Act, supra, the statutory pricing standard was not expressed in terms of cost recovery. Rather the original pricing standard for uranium enrichment services in subsection 161(v) of the Atomic Energy Act of 1954, as amended, was "on a basis which will provide reasonable compensation to the Government." 78 Stat. 603, 606. Moreover, the Joint Committee on Atomic Energy directed that the phrase "reasonable compensation to the Government" should be construed flexibly, to take into account not only (1) the Government's costs in providing enrichment services, but (2) the national interest in the development and utilization of nuclear power. 14/ In addition, in 1964 the Joint Committee on Atomic Energy deemed it consistent with this statutory standard for the AEC not to recover from customers depreciation attributed to shutdown portions of the diffusion plants, to meet the immediate problem of a substantial decline in enrichment services needed for military purposes. Id.

The first uranium enrichment services criteria were developed in 1966 under this flexible statutory standard. Each of the underscored items in the criteria above were adopted then and remain today. During the course of the congressional hearings on the proposed criteria, the AEC asserted

13/ A detailed staff study of the "Legislative History of Statutory Costing Provisions Governing the Uranium Enrichment Program" appears as Appendix III to this letter opinion.

14/ H.R. Rep. No. 1702, 88th Cong., 2d Sess. 17 and 18 (1964); S. Rep. No. 1325, 88th Cong., 2d Sess. 17 and 18 (1964).

that the basic policy was one of full cost recovery, 15/ with one exception. That was, not to charge full depreciation on excess capacity during an interim beginning period, since the plants had essentially been built for military purposes and the civilian market had not yet grown sufficiently to fully utilize plant capacity. The formula by which this partial depreciation exclusion was calculated became known as the Conway Formula. The formula required recovery of depreciation and interest costs only to the extent of the percentage of plant production capacity used plus 10 percent, but with a floor of 30 percent depreciation and interest recovery without regard to proportion of plant use. This standard was to be applied until plant use reached 75 percent of plant capacity, at which point 100 percent of depreciation and interest costs were to be recovered.

The flexibility of the language of the Private Ownership of Special Nuclear Materials Act, supra, was constrained by amendment in 1970. Section 8 of Public Law No. 91-560, approved December 19, 1970, 84 Stat. 1472, 1474, changed the basis of pricing for the toll enrichment program from "reasonable compensation to the Government" to "recovery of the Government's costs over a reasonable period of time." The effect of these changes was to narrow the permissible meaning of the criteria language on depreciation cost recovery and to preclude non-recovery of full costs for the toll enrichment program, except for the one situation where the Conway Formula was applicable.

Whatever may have been the flexibility ascribed in the past to the phrases "appropriate Government costs" and "appropriate depreciation of said plants" in the criteria, after the enactment of the 1970 amendment to subsection 161(v) these phrases were constrained by the coverage of the new statutory language. The criteria cannot be inconsistent with the statute which they implement. Even though these phrases in the criteria have not changed since 1966, their permissible interpretation has been constrained since their adoption by subsequent enactment of legislation on which they depend. Therefore, full cost recovery, including depreciation, was statutorily required after 1970 in every instance except where the Conway Formula is applicable.

15/ Uranium Enrichment Service Criteria and Related Matters, Hearings Before the Joint Committee on Atomic Energy, 89th Cong., 2d Sess. 31, 32 and 112 (August 2, 3, 4, 16 and 17, 1966).

Write-off

Applying these principles to the specific situation presented now regarding Energy's gaseous diffusion plants, we conclude that a write-off for pricing purposes of Energy's undepreciated plant and capital equipment attributable to unused production capacity violates the statutory mandate of subsection 161(v) of the Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2201(v), requiring cost recovery for Energy's uranium enrichment program.

We have been advised that Energy achieved 77.1 percent of production capacity from its gaseous diffusion plants in 1976. Since Energy achieved greater than 75 percent of production capacity, the interim period in which the Conway Formula applied thereby expired. Thereafter, in accordance with the Conway Formula, Energy should have recovered 100 percent of plant and equipment depreciation from customers regardless of the percentage of production capacity achieved in any given year. In fact, from 1977 through 1983 Energy did include 100 percent of depreciation in its prices, even though the percentage of production capacity never again reached 75 percent.

For fiscal year 1984 Energy is planning to disregard past practices and write-off undepreciated plant and capital equipment attributable to unused production capacity. This action will result in a shifting of approximately $1.2 billion in program costs from customers to the Government. This in effect constitutes a subsidization of the enrichment program in contravention of the Atomic Energy Act of 1954, as amended, and its legislative history. Since Energy is not authorized under subsection 161(v) and its implementing criteria to charge less than 100 percent depreciation in current market circumstances, we find the write-off of undepreciated assets to be legally objectionable. If such assets are to be written-off, Congress must amend the Act. A criteria change would not suffice, since the criteria must be in accord with the statute.

The nuclear industry is not threatened by current uranium enrichment market conditions. Indeed, the industry may be benefitting from the competition for enrichment services. Therefore, it is not the development of atomic power that is being impeded but the ability of the United States enrichment program to compete in the world market under its legislative structure. This situation does not fall within the one exception for which Congress approved less than full cost recovery.

Revaluation of Feed Inventory

The second change Energy made to attempt to achieve a low price of $135/SWU and remain in compliance with the statutory requirement that it recover its costs from the uranium enrichment program was to revaluate its uranium feed stockpile for purposes of establishing a use price from market price to acquisition cost. We conclude that this pricing practice is not governed by Generally Accepted Accounting Principles. In addition, the Atomic Energy Act of 1954, as amended, has sufficient flexibility to permit such a revaluation, but for concern over the impact on the domestic uranium mining and processing industries. However, Energy could not legally price uranium feed from its stockpile in conjunction with its enriching services at any price below its acquisition cost.

Facts

Energy has in stock quantities of natural uranium that can be used as feed to produce enriched uranium. This stock was accumulated over a number of years, primarily when the U.S. Government by law could be the only owner of source materials. The stock was needed for defense purposes. In addition, the Government purchased substantial natural uranium to try to generate a viable private, commercial uranium mining industry. With the enactment in 1964 of the Private Ownership of Special Nuclear Materials Act, supra, civilians in the private sector were authorized to own special nuclear materials. In addition, in the contracts under the toll enrichment program, the customers are obliged to supply the feed for their orders. These policies have enabled the development of the civilian nuclear power industry while still permitting the maintenance of the Government's uranium stockpile.

In the long-term contracts (up to 30 years) for enrichment services under the toll enrichment program, the customer is obliged to supply a given quantity and chemical quality of uranium feed to produce the purchased quantity of enriched uranium under the standard operating procedures at Energy's gaseous diffusion plants. However, physically and chemically Energy can modify its operating procedures within certain limits. For example, a given quantity of enriched uranium can be produced by using a smaller quantity of uranium feed and a larger amount of electric power or by using a larger quantity of uranium feed and a smaller amount of electric power.

Since electric power is now relatively expensive, Energy has decided that it would be more cost effective to modify its standard operating procedures so as to use more uranium feed and less electric power. However, to do this, Energy needs more uranium feed than the customer is contractually obligated to supply under its long-term contract. In these circumstances, Energy has decided to obtain the needed additional uranium feed from its stockpile, and to value it for this purpose at acquisition cost (approximately $9 per pound) rather than at current market price (approximately $40 per pound).

GAAP and Feed Revaluation

As stated earlier, Generally Accepted Accounting Principles apply to general purpose financial statements used for external reporting. They are not primarily intended to be the basis for pricing decisions. This revaluation of Energy's uranium feed stockpile for purposes of accounting for its use in the enriching process is a pricing decision.

According to Energy the book value of its feed inventory is reported on the program's financial statement at average acquisition cost. This reporting method is in accordance with GAAP. The program's inventory valuation for financial statement reporting will not be affected by Energy's action.

Inventory Price

Energy uses its uranium stockpile in two ways: (1) as a source of direct supply of uranium feed to its customers, or (2) as a means of reducing electricity use in the enriching process.

When Energy supplies uranium to its customers from its inventory, the transaction has been considered a sale and the price Energy charges has been established in accordance with the standards set forth in subsections 63(c) and 161(m) of the Atomic Energy Act of 1954, as amended, 42 U.S.C. §§ 2093(c) and 2201(m). These standards provide that the selling price for source material, such as uranium feed, must (1) provide reasonable compensation to the Government, and (2) not discourage the development of private sources of uranium. Energy has stated that under these standards and due to varying market conditions over the years, uranium sold has been priced below acquisition cost, at acquisition cost, and above acquisition cost. Since 1977 Energy has been selling uranium from its inventory at average market price. Our understanding is that this practice will not change.

On the other hand, our understanding is that in the past the same methodologies applied in the situation where Energy used uranium feed from its stockpile, for management and cost efficiency reasons, as a means of operating its plants at lower electricity levels, without any direct feed transactions with a customer. This use of stockpile feed was thus treated as a sale by Energy. Now, however, Energy intends to value feed used in this manner at acquisition cost rather than market price. A statutory standard of reasonable compensation to the Government would legally seem to have sufficient flexibility to permit such a pricing revaluation, although it may not always make good economic sense. However, if Energy no longer treats or considers this use of its uranium stockpile as a sale, one consequence is that the other element of the pricing standards of subsection 161(m) of the Atomic Energy Act of 1954, as amended, supra, may not have to be complied with. That is, Energy may not have to assure that its use of its uranium stockpile in this manner will not discourage the development of independent sources of uranium supply. Use of one's stockpile at acquisition cost, which is substantially lower than market price, discourages purchases in the ordinary course from the domestic uranium mining and milling industries. This will undoubtedly further weaken industries which Energy has testified to Congress are in an acute depression with numerous mine closings. 16/ We have not fully examined these matters, but the impact on the uranium mining and milling industries is of some concern.

In addition, Energy could not legally use or sell uranium feed from its stockpile in conjunction with its enriching services at any price below its acquisition cost. Subsection 161(v) of the Atomic Energy Act of 1954, as amended, 5 U.S.C. § 2201(v), governs the toll enrichment program. It requires that the Government recover its costs in providing uranium enriching services. In addition, subsection 4(c)(2) of the implementing uranium enrichment services criteria provides that the cost of separative work includes the direct and indirect costs of operating the enrichment plants, presumably including the costs of Government feed when used. 44 Fed. Reg. 28875, 28876 (May 17, 1979). Moreover, the Joint Committee on Atomic Energy directed that "In the establishment of

16/ See, e.g., Testimony of Mr. Shelby T. Brewer, Assistant Secretary for Nuclear Energy, Energy and Water Development Appropriations for 1985, Part 6, Hearings Before the Subcommittee on Energy and Water Development, House Committee on Appropriations 917 (March 19, 1984).

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reasonable sales prices for special nuclear material, it is expected that the Commission [now Energy] will follow, to the extent feasible, the principle of full cost recovery." H.R. Rep. No. 1702, 88th Cong., 2d Sess. 24 (1964); S. Rep. No. 1325, 88th Cong., 2d Sess 24 (1964). Therefore, in this context, we believe the sales or use price of uranium feedstock must, at least, recoup the acquisition costs to the Government. 17/

Finally, although we find that the pricing revaluation decision was a judgmental determination within Energy's discretion and authority to make, we do not necessarily agree that it was wise. We recognize that the decision to revaluate and use the feedstock may prove to be shortsighted. It is projected that the stockpile will need to be replenished in the early 1990's. Energy may have to replace its stocks at higher market prices, which, if and when used, will cause the price of enrichment services to rise.

In summary, the burden of our analysis raises serious concerns about the actions Energy has taken both substantially and procedurally. As we have stated on a number of occasions in the past, there is a compelling need, because of the market changes and constraints imposed by full cost recovery pricing in the current market environment, for the executive branch and the Congress together to reexamine the fundamental purpose and structure of the uranium enrichment program. Such a reexamination must consider our nation's objective for serving the domestic and international uranium enrichment markets and provide adequate flexibility in pricing policies to allow effective competition with foreign suppliers.

Sincerely yours,

Milton J. Socolar

for Comptroller General
of the United States

17/ Acquisition cost might perhaps be too narrow a term. Related carrying, storage and other costs should perhaps be added to acquisition cost. We have not carefully explored this issue. Our analysis here is primarily one of contrasting the propriety of a cost-based price versus a market-based price.

APPENDIX I APPENDIX I

ENERGY'S DESCRIPTION OF THE PURPOSE AND ANTICIPATED IMPACT OF EACH MAJOR FEATURE OF ITS NEW UTILITY SERVICES CONTRACT

"1. Ability to purchase between 70 and 100 percent of the customer's annual enrichment requirements from DOE.

"This contract feature obligates DOE [Energy] to produce, and the customer to purchase, only a given portion of a customer's actual enrichment needs, and is designed to stabilize DOE's market share and strike a closer balance between future DOE supply and demand. By linking the contract to the customer's actual fuel requirements, the build-up of future excess enriched uranium inventories can be avoided, and a more realistic and predictable demand base for future production and capacity expansion planning can be achieved. Flexibility is provided to the customer to purchase up to 30 percent of his needs from another source. This flexibility permits an orderly reduction in world excess inventories of enriched uranium, as well as opportunities for diversification of supply and enhanced fuel economies to the customer as a result of freer competition. Because the contract permits customers to purchase as little as 70 percent of his supply from DOE, the Government's obligation to its customers could potentially be less than it was under previous contract forms. Customers may increase or decrease their percentage commitment only upon 5-years advance notice to DOE in order to provide adequate time for DOE to make necessary production arrangements.

"2. Reduced leadtime (180-days in advance of delivery) to firm up delivery quantities.

"This feature complements the requirements characteristic of the contract discussed above in that it is designed to permit the customer to closely match his actual delivery quantities with his actual fuel needs. Longer leadtimes for firm-up have in the past forced customers to take excess quantities of material because they have had to order fuel too far in advance of knowing their actual requirements. The 180-day leadtime for firm-up is within the production leadtime required by DOE to produce enrichment services. The Department's existing Requirements contracts require only 180-day leadtime for delivery. DOE has operated with this leadtime requirement since 1969 for the majority of its deliveries, and has complete confidence in its ability to do so for all deliveries in the future. The impact of this provision on the Government is beneficial for two reasons: it avoids the requirement to produce excess material in the future, and avoids the year-end concentration of deliveries at the enrichment plants caused by previous fixed-commitment contracts.

"3. Extended period of commitment by the customer by increasing the amount of notice required for termination without penalty.

"The US contract [Utility Services Contract] requires a minimum of 10-years notice for free termination. Termination penalties have also been increased compared to previous DOE contracts. This feature is designed to stabilize DOE's deliveries and insulate DOE's revenue base from the market uncertainties associated with secondary market transactions and associated price instabilities. The impact of this provision on the Government is thus a positive one, providing adequate time for DOE to respond to future decreases in demand. It also requires customers to make an extended obligation to DOE in exchange for increased flexibilities in other contract terms.

"4. Flexibility to select tails assay within a given range.

"The US contract provides a Variable Tails Assay Option (VTAO) to the customer within a guaranteed range of 0.20 percent - 0.30 percent U-235. A fee for this service is required. The objective of this feature is to provide the customer with the opportunity to more closely optimize his fuel costs. VTAO is available under the majority of primary supplier contracts in the market, and has been offered by DOE in a more restricted form under its Adjustable Fixed-Commitment contracts. VTAO will enhance DOE's ability to compete with the aggressive initiatives of its competitors, protect its existing market share and capitalize upon future sales opportunities. VTAO represents a potential additional perturbation in the quantity of separative work units (SWU) to be purchased by customers caused by the selection of any tails assay between 0.20 and 0.30 percent U-235. However, two factors compensate for this effect. First, DOE has the operational flexibility to adjust power levels, feed rates, and operating tails assays to accommodate variations in SWU sales as a result of VTAO. Secondly, to the degree that this operational flexibility is inadequate to resolve the effect of sales adjustments from customers exercising the US contract VTAO option, a fee has been established for the use of VTAO which will provide additional revenues to ensure the financial stability of the enterprise. Therefore, the impact of VTAO should be positive with respect to enhancing DOE's competitive posture with adequate protective measures to accommodate any potential sales variations from its use.

"5. Price protection in the form of a long-term price ceiling.

"The US contract contains a ceiling charge provision that obligates the Government to provide enrichment services at prices that do not exceed a calculated ceiling charge. Price ceiling protection has been provided in the past by the Department in its Requirements contracts. The US contract thus extends price ceiling protection to those fixed-commitment customers that convert to the US contract. Incorporation of a price ceiling as a contractual obligation was required for DOE to remain competitive in the enrichment market. All other forms of non-US primary supplier contracts contain some form of price ceiling protection.

"Price is an important factor in the enrichment market. The ability to provide enrichment services at low prices, which are stable and predictable over time, is the challenge that DOE must address in order to meet its customers needs and be competitive with foreign producers. However, market benefits associated with projected low enrichment prices in the near and long term are rendered ineffectual in the absence of some form of price ceiling to protect against future increases. Therefore, an enrichment program strategy with production cost efficiencies and options for deploying advanced technologies must be implemented to result in low enrichment prices and to include some guarantee against unforeseen price increases. This combination is paramount in establishing customer confidence and subsequently a stable sales base for DOE.

"The ceiling charge is another manifestation of DOE's responsibility to control program costs and prices in a businesslike manner. DOE is confident of its ability to reduce production costs and deploy more efficient advanced technologies to not only maintain prices within the ceiling limit, but in fact, to reduce prices below future US contract ceiling charge levels. * * * The Department's commitment to recover costs within the ceiling is further emphasized by the fact that the Department cannot charge prices greater than the ceiling charge unless 10-years advance notice is given to the customer. However, this override protection was included in the contract to assure that DOE's cost recovery obligation could be met even in the event that unforeseen circumstances materially change future market conditions."

APPENDIX II

APPENDIX II

LEGISLATIVE HISTORY OF 1973 AMENDMENTS TO URANIUM ENRICHMENT SERVICES CRITERIA

The first uranium enrichment services criteria had been developed in 1966. See 31 Fed. Reg. 16479 (December 23, 1966). They had specified two standard types of contracts--Firm Quantities Contracts and a Requirements Contract. The basic principles of each type had been set forth along with the more significant provisions of the contracts. In 1973 the AEC, a predecessor agency of Energy, attempted to make the uranium enrichment services criteria contain more general, generic terms and conditions than had been in the earlier criteria. However, the AEC's effort ultimately was largely unsuccessful.

In hearings before the Joint Committee on Atomic Energy in 1973, Mr. George F. Quinn, Assistant General Manager for Production and Management of Nuclear Materials, explained the AEC's objective, in part, as follows:

> "The proposed revisions to the uranium enrichment services criteria include charges necessary * * * to afford appropriate flexibility to incorporate changes in the contracting details as may be warranted by experience * * *." 1/

Some flavor of the AEC's proposed 1973 criteria modifications can be illustrated by a part of Mr. Quinn's statement with regard to contract termination provisions:

> "* * * The quantitative terms and conditions for termination by the customer of an enrichment services contract are, therefore, not specified in the criteria and will not be set forth in individual contracts.

1/ Proposed Changes in AEC Contract Arrangements for Uranium Enriching Services, Hearings Before the Subcommittee on Energy, Joint Committee on Atomic Energy, 93rd Cong., 1st Sess. 19 (March 7, 8, 26; and April 18, 1973).

"Instead, they would be announced, and periodically updated as may be necessary, by notices in the Federal Register. Other features of the enrichment services contract which are subject to change because of external conditions are also proposed to be subject to modification, as needed, by appropriate notices in the Federal Register." 2/

The AEC sustained considerable opposition to its 1973 proposed criteria modifications, both from industry and members of the Joint Committee on Atomic Energy. A few examples of congressional reaction taken from the 1973 hearings, supra, are illustrative:

1. "Senator Jackson. * * * the revised criteria omit any reference to the types and significant details of the contracts under which enrichment services will be provided." (Page 2.)

2. "Representative Price. Since the significant features of the new types of contracts are not described in the criteria there appears to be nothing that would require the Commission to return to the Joint Committee should it decide to vary the terms and conditions under which it would provide the uranium enrichment services. This seems to be a substantial departure from the intent of section 161v. * * *" (Page 32.)

3. "Representative Price. Of course you can shorten the time of many things if you depart from the law. * * * Even we nonlegal members of the committee can see that you are ignoring a section of the Atomic Energy Act." (Page 33.)

2/ Id., at 22.

4. "Representative Holifield. It is very clear on the face of it that this is a move, justified on the basis of a new arrangement, to evade or to nullify congressional control. * * * It seems to me that this is a very convenient way to say that it is too complicated and, therefore, we want to change the law, or evade it, in order to keep congressional control from taking place." (Page 33.)

5. "Mr. Minsch [Assistant General Counsel, AEC]. Mr. Holifield, on the legal point you raised we, of course, are still subject to the statutory requirement of section 202 that we keep the Joint Committee currently informed."

"Representative Holifield. It is one thing to keep us currently informed and another thing to reduce the power for us to do anything about it after you inform us." (Page 34.)

6. "Representative Holifield. * * * What control do you feel the Joint Committee will have over the essential terms and conditions of this or any other contract for enriching services under the new criteria?"

"Mr. Allen [President, Yankee Atomic Electric Co., and Vice President, New England Electric System]. None."

"Representative Holifield. Thank you. I came to the same conclusion. * * * The new criteria would eliminate any supervision of this committee over these things." (Page 83.)

The result was that the criteria modifications were not adopted as proposed in 1973. The Joint Committee on Atomic Energy held 4 days of hearings on them. The Committee also requested an extension of the 45-day review period from the

AEC and a deferral of criteria modifications, and the AEC granted both requests. 3/ The Committee, in the interim, insisted that the AEC consult with both representatives of industry and the Committee staff to try to achieve more acceptable criteria modifications.4/ Modification of the uranium enrichment services criteria, that was proposed by the AEC to the Joint Committee on January 18, 1973, was not concluded until May 7, 1973, a period of more than 100 days. The modifications ultimately adopted differed significantly from those first proposed.

The criteria revisions of 1973 as originally proposed gave the AEC great latitude in the operation of the uranium enrichment program, including eliminating references to any particular type of contract. This original proposal was unacceptable to both the Joint Committee on Atomic Energy and the nuclear industry, and it was rejected. The proposed criteria were then revised to contain various changes in the areas of (1) assurances of consultations with customers regarding any future contract changes which might have adverse effects on them; (2) clarification of assurances regarding non-discrimination in Government termination of contracts; (3) clearer enunciation of the intended maximum customer termination charges; and (4) increases in the advance notice period to increase enriching service charges. Many of these were reinsertions of provisions already contained in the 1966 criteria but with slight modifications. More importantly, the Fixed Commitment Contract was specified as the required primary contracting vehicle for supplying enriching services for nuclear power reactors on a long-term basis. The AEC did succeed in deleting the principles relating to the Requirements contract and the guaranteed ceiling price. Most of the 1966 criteria provisions were retained.

3/ Id., at pages 183 and 187.

4/ Id., at pages 188-194 and 196-198 for listings of the issues in dispute and the positions of the respective parties.

APPENDIX II APPENDIX II

The 1973 experience and its background are particularly instructive regarding a guaranteed ceiling price. Initially, in 1966 when the first uranium enrichment services criteria were established, they specifically provided for a guaranteed ceiling price. Subsection 5(d) stated:

> "(d) Ceiling on charge for enrichment services. The contract shall specify for the term of the agreement a guaranteed ceiling charge, subject to upward escalation for the cost of electric power and labor. The ceiling charge as of July 1, 1965, the base date for application of escalation, is $30 per Kg unit of separative work for separation of U-235 from U-238. (In its standard table of enriching services, as well as its schedule of charges for sale or lease of enriched uranium, AEC will take into account any significant effect of the presence of other isotopes of uranium on the number of separative work units required to perform a given U-235, U-238 separation.)" 31 Fed. Reg. 16479, 16480 (December 23, 1966).

This guaranteed ceiling price provision was purposely deleted from the uranium enrichment services criteria in the 1973 amendments on the initiative of the AEC. The AEC provided an extensive rationale justifying its deletion:

> "The present requirement that enriching services contracts which may cover periods as great as 30 years contain a guaranteed ceiling charge of $30 subject to escalation for costs of electric power and labor was deleted as it is considered no longer necessary, and it could preclude compliance with the statutory directive to recover the Government's costs over a reasonable period of time should the Government have to undertake the construction of additional enrichment capacity. Incorporation of the ceiling price concept in the Criteria occurred at a time when cost data concerning operation of the enrichment plants was classified and it served to provide customers with

> some assurance as to the future economics of uranium enrichment, as a basis for their long-term planning.
>
> "Now, however, since cost information on the existing plants and estimates with regard to future diffusion plants are no longer classified, and since the Act now specifies that the AEC charge be based on its costs, the original purpose of the ceiling charge would no longer be appropriate at the time that new enriching capacity might be undertaken. The escalation provisions of the existing ceiling charge relate specifically to the existing plant capacity; they contain no provision for escalation in the cost of the capital or in construction costs which, of course, would be reflected in the economics of any new plant capacity to be built. Thus, it is possible that the enriching costs of new plant capacity built in the future could exceed the escalated ceiling charge which was incorporated into the original Criteria and which clearly was applicable only to the existing plants."5/ (Emphasis added.)

The arguments were frequently repeated during the 1973 hearings. See, e.g., pages 21, 157, 451, 452, and 664. In fact, in response to a question from the Joint Committee asking if the AEC would object to the restoration of a ceiling charge in the criteria, the AEC answered:

> "* * * Since its [the ceiling price] inclusion could be prejudicial to the Government's financial interest and no other clear purpose is being served, the AEC continues to believe that it should be deleted from the Criteria." Id., at 664.

Consequently, all of the provisions concerning a guaranteed ceiling price were in fact deleted from the uranium enrichment services criteria in 1973 at the insistence of the AEC.

5/ Proposed Changes in AEC Contract Arrangements for Uranium Enriching Services, Hearings Before the Subcommittee on Energy, Joint Committee on Atomic Energy, 93rd Cong., 1st Sess. 446 (March 7, 8, 26; and April 18, 1973).

Now some 11 years later, the AEC's successor agency, looking at the uranium enrichment services criteria from which all provisions concerning a guaranteed ceiling price had been purposely deleted, claims those criteria permit a guaranteed ceiling price, without pointing to any specific section of the criteria to support its position. There have been no relevant changes to the criteria in the intervening 11 years. We did not find anything in the 1973 legislative history that would support Energy's position. All of the evidence that we have seen points in the direction that guaranteed ceiling prices were neither wanted in the criteria nor in enrichment contracts.

In addition, the concern which prompted the AEC to delete the guaranteed ceiling price provisions from the criteria in 1973 still seems to prevail today, namely, the fear that a guaranteed ceiling price could preclude compliance with both the statutory and criteria directive to recover the Government's costs over a reasonable period of time, particularly in a competitive international uranium enrichment market and while the Government is undertaking the construction of additional enrichment capacity.

Energy does assert that a 1973 GAO report 6/ offers support for its

> "* * * determination that no criteria change was required in order to include a ceiling price provision in the * * * [Utility Services Contract]. GAO expressly recognized in its 1973 analysis of the criteria now in effect that, despite the Department's decision to exclude a ceiling charge provision from the fixed - commitment contracts (first offered in

6/ Proposed Revisions to the Criteria and Contracts for Uranium Enrichment Services, B-159687, March 5, 1973, reprinted in Proposed Changes in AEC Contract Arrangements for Uranium Enriching Services, Hearings Before the Subcommittee on Energy, Joint Committee on Atomic Energy, 93rd Cong., 1st Sess. 311-359 (March 7, 8, 26; and April 18, 1973).

1973), the Government would not be prohibited under the proposed criteria from offering price ceiling protection under the terms of contracts that specifically provide for such protection." (Emphasis added.)

However, we find this interpretation of our report to be without foundation.

GAO's report stated that:

"The elimination of the ceiling charge will not apply to customers who elect to continue to operate under requirements contracts because these contracts contain the following provision:

"The charges to be paid to the Commission for enriching services provided to the Customer hereunder shall be determined in accordance with the established Commission pricing policy for such services; provided, however, that the unit charge for enriching services during the term of this agreement shall in no event exceed a ceiling charge * * *." Id., at 22.

All GAO said and meant was, where a then-existing requirements contract contained the ceiling price language quoted, the Government would honor that contract provision, since the AEC had no authority to breach existing contracts. Those contracts were governed by the criteria in existence at the time the contracts were consummated. Contracts consummated after 1973, however, would be governed by the uranium enrichment services criteria, as modified in 1973. Consequently, after 1973 the AEC would likely be administering both contracts with a guaranteed ceiling price and other contracts without a guaranteed ceiling price, the former consummated before the criteria revisions became effective and the latter consummated after the criteria revisions. This does not imply that the AEC could "offer" to sign new contracts after 1973 that still contain a guaranteed ceiling price, even though the guaranteed ceiling price provisions had been deleted from the criteria. New requirements contracts were no longer offered after 1973.

APPENDIX III APPENDIX III

LEGISLATIVE HISTORY OF STATUTORY COSTING PROVISIONS GOVERNING THE URANIUM ENRICHMENT PROGRAM

Early Statutory Legislative History

When the toll enrichment program was first authorized in the Private Ownership of Special Nuclear Materials Act, supra, the statutory pricing standard was not expressed in terms of cost recovery. Rather the original pricing standard for uranium enrichment services in subsection 161(v) of the Atomic Energy Act of 1954, as amended; was "on a basis which will provide reasonable compensation to the Government." 78 Stat. 603, 606. Pricing for enriching services was an issue of no small concern to the Joint Committee on Atomic Energy. Indeed the matter was discussed at length by the Committee before the enactment of the Private Ownership of Special Nuclear Materials Act:

> "One of the recurrent problems discussed in the committee's hearings on this legislation was the uncertainty with respect to the Commission's charges for separative work under uranium enrichment service arrangements. The problem was most sharply illustrated by reference to a disarmament situation, under which the Commission would have to meet no further requirements for special nuclear material for weapons purposes. In such a situation, the major market for the output of the diffusion plants would be nuclear power reactors--a requirement that is expected to be small in the near-term compared to the production capacity of the AEC plants.
>
> "This problem has, to some extent, already been posed by the cutback in the production of special nuclear materials announced this year by the President. To alleviate industry concern with respect to the effect of those cutbacks on the charges for enriched uranium, the AEC announced on June 4, 1964, that it did not plan to increase its published charges for enriched uranium. The AEC stated that even in maintaining its current schedule of charges--

"The Government would still recover its full costs of separative work, although those portions of the diffusion plant shut down as a result of the cutback would not be amortized against current production.

"In the Committee's view, this policy should assure reasonable compensation to the Government. But, it will be immediately recognized that this policy may only be an interim measure to meet an immediate problem. In the situation of a virtual or complete elimination of production for weapons purposes, alternative modes of diffusion plant operation would have to be considered.

* * * * *

"It is too early to predict with certainty the precise dimensions of this problem or the best method of solution. However, the statement in new subsection 161v, that charges for enrichment services shall be established on a basis which will provide 'reasonable compensation to the Government' is flexible. In arriving at this determination the Commission will have to consider not only the Government's costs in providing enrichment services but also the national interest in the development and utilization of nuclear power.

"This is a matter the Committee intends to follow very closely in the years ahead. Indeed the Congress, through the Joint Committee, will have an important role in evaluating the terms and conditions under which uranium enrichment services are offered since the criteria setting forth these terms and conditions will have to be submitted to the committee and lie before the committee in accordance with the provisions of new subsection 161v." (Emphasis added.) H.R. Rep. No. 1702, 88th Cong., 2d Sess. 17 and 18 (1964); S. Rep. No. 1325, 88th Cong., 2d Sess. 17 and 18 (1964).

Thus in 1964 the Joint Committee on Atomic Energy deemed it consistent with the statutory standard "reasonable compensation to the Government" for the AEC not to recover from customers depreciation attributed to shutdown portions of the diffusion plants, to meet the immediate problem of a substantial decline in enrichment services needed for military purposes. Moreover, the Joint Committee directed that the phrase "reasonable compensation to the Government" should be construed flexibly, to take into account not only (1) the Government's costs in providing enriching services, but (2) the national interest in the development and utilization of nuclear power.

Development of Criteria Language

In 1966 the AEC proposed criteria implementing subsection 161(v) of the Atomic Energy Act of 1954, as amended, supra, and specifying the terms and conditions under which toll enrichment services would be provided to customers. Five days of hearings were held on the proposed criteria. 1/

During the course of these hearings, Mr. John P. Abbadessa, Controller of the AEC, stated the cost elements to be included in customer fees and, in particular, stated the proposed pricing policy of the AEC regarding excess plant capacity. The pricing policy would be "in accordance with the established full cost recovery of the Commission with this exception related to excess capacity." Id., at 32. Dr. Glenn T. Seaborg, Chairman of the AEC, reaffirmed that "the Commission's basic policy is one of full cost recovery * * *." Id., at 112.

The basis for the single exception to full cost recovery was explained by Mr. Abbadessa as follows:

> "* * * What is involved here * * * is that we would not pass on to private industry the costs associated with unused capacity in these large plants which were built essentially for military purposes.

1/ Uranium Enrichment Service Criteria and Related Matters, Hearings Before the Joint Committee on Atomic Energy, 89th Cong., 2d Sess. (August 2, 3, 4, 16 and 17, 1966)

"* * * In determining our depreciation and interest on the investment of the Government, we used a percentage approach which is to charge the toll enrichment program with that portion of our capacity that is used for toll enrichment purposes and to charge the unused capacity to national defense.

"We think this results in a full cost charge to the toll-enrichment program. We also think it is consistent with the legislative history." Id., at 31.

The criteria language that the AEC proposed to implement this policy included each of the items underscored above in the text in the section on "Pricing Constraints."

Mr. John T. Conway, Executive Director of the Joint Committee on Atomic Energy, did not totally agree with the AEC. He felt that if private industry were building a plant, they would normally build in some additional capacity. Thus, since the diffusion plants were supposed to operate somewhat comparable to a commercial enterprise, the customers should pay depreciation on some of the excess capacity. Id., at 61-65 and 131-132. GAO in its report to the Joint Committee, B-159687, August 1, 1966 (reprinted in the Hearings at 333-341), also expressed some reservations about excluding from the toll enrichment charge depreciation and imputed interest costs attributable to excess capacity. Id., 336-337. GAO estimated that $150 million, during the 3-year period 1969 through 1971 when production was expected to be low, would be charged to national defense instead of the toll enrichment program. Id., at 32. All parties agreed that the program should not provide a Government subsidy to the industry. See, id., at 29, 33, 121, 319, 517 and 518.

Mr. Conway's concerns were satisfied by the development of the Conway Excess Capacity Formula (Conway Formula). The agreement was consummated in an exchange of letters between

the Joint Committee and the AEC. 2/ This agreement did not necessitate a modification in the proposed criteria language, but constituted a change in AEC policy in interpreting and implementing the criteria language. In brief, the Conway Formula provided that a portion of costs attributable to depreciation and interest on plant investment associated with unused excess capacity would be temporarily excluded from the price calculation and charged to national defense. The formula required recovery of depreciation and interest costs only to the extent of the percentage of plant production capacity used plus 10 percent, but with a floor of 30 percent depreciation and interest recovery without regard to proportion of plant use. This standard was to be applied until plant use reached 75 percent of plant capacity, at which point 100 percent of depreciation and interest costs were to be recovered.

Thus, the criteria adopted in 1966, consistent with the language of the Private Ownership of Special Nuclear Materials Act and its legislative history, did include language allowing some flexibility. This language, however, and its implementing Conway Formula were designed for an interim period to deal with a specific immediate problem, namely, a temporary substantial excess production capacity due to the decline in enrichment services needed for military purposes. This was explicitly recognized by the AEC in a January 26, 1971, letter to the Joint Committee on Atomic Energy. In response to a specific question, the AEC then stated "The significance of the inclusion of the word 'appropriate' in the first sentence of Subparagraph (2) [of subsection 4(c) of the criteria] is to preserve the Conway formula * * *." 3/

2/ Letter from Chairman Chet Holifield, Joint Committee on Atomic Energy, to Dr. Glenn T. Seaborg, Chairman, AEC, dated October 18, 1966, and a responding letter from Chairman Seaborg to Chairman Holifield, dated December 16, 1966. Both letters are reprinted in the 1966 Hearings at 517-519.

3/ Uranium Enrichment Pricing Criteria, Hearings Before the Joint Committee on Atomic Energy, 92d Cong., 1st Sess. 6 (February 25, 1971).

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APPENDIX III APPENDIX III

1970 Statutory Amendment

The flexibility of the language of the Private Ownership of Special Nuclear Materials Act, supra, was constrained by amendment in 1970. Section 8 of Public Law No. 91-560, approved December 19, 1970, 84 Stat. 1472, 1474, changed the basis of pricing for the toll enrichment program from "reasonable compensation to the Government" to "recovery of the Government's costs over a reasonable period of time." In addition, the legislative history of the amendment further clarifies even the new language. The effect of these changes was to narrow the permissible meaning of the criteria language on depreciation cost recovery and to preclude non-recovery of full costs for the toll enrichment program, except for the one situation where the Conway Formula was applicable.

The 1970 amendment was a congressional reaction to an attempt by the AEC in 1969 to base its toll enrichment prices on a standard of the needs of a hypothetical, private, commercial corporation rather than on a cost recovery standard. The Joint Committee on Atomic Energy recommended that "the original legislative intent be reiterated and the wording of the statute buttressed in support of its intended purpose. 4/ In the process, it chastised the AEC by stating that "The Committee expects that this reiteration of congressional intent would preclude any further attempt to deviate from the purpose of the statute."5/ The Joint Committee then proceeded to restate its intent and to incorporate by reference a GAO legal interpretation 6/ of the meaning of subsection 161(v).7/

4/ H.R. Rep. No. 1470, 91st Cong., 2d Sess. 2 (1970); S. Rep. No. 1247, 91st Cong., 2d Sess. 2 (1970).

5/ Id., at 25.

6/ Review of Proposed Revisions to the Price and Criteria for Uranium Enrichment Services, B-159687, July 17, 1970, at 9, reprinted in Uranium Enrichment Pricing Criteria, 91st Cong., 2d Sess. 161-238 (June 16 and 17, 1970).

7/ H.R. Rep. No. 1470, supra, at 22; S. Rep. No. 1247, supra, at 22.

In so doing, the Joint Committee explicitly affirmed GAO's legal interpretation of the meaning of subsection 161(v) as the Committee's intended meaning of the new statutory language requiring "recovery of the Government's costs over a reasonable period of time." GAO's opinion required the recovery of costs in every instance except one, namely, the situation for which the Conway Formula had been devised to deal with the reduction or possible elimination of the military need for enriched uranium. Flexibility and consideration of the national interest were directed specifically and solely at this particular problem.

Whatever may have been the flexibility ascribed in the past to the phrases "appropriate Government costs" and "appropriate depreciation of said plants" in the criteria, after the enactment of the 1970 amendment to subsection 161(v) these phrases were constrained by the coverage of the new statutory language. The criteria, having the legal force and effect of regulations, cannot be inconsistent with the statute which they implement. Even though these phrases in the criteria have not changed since 1966, their permissible interpretation has been constrained since their adoption by subsequent enactment of legislation on which they depend. Therefore, full cost recovery, including depreciation, was statutorily required after 1970 in every instance except where the Conway Formula is applicable.

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

B-207463

February 19, 1986

The Honorable Edward J. Markey
Chairman, Subcommittee on Energy
Conservation and Power
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

By letter of February 6, 1986, you requested that GAO provide a legal opinion on the consistency of the Department of Energy's (Energy) proposed revised uranium enrichment services criteria with the requirements of law. These proposed criteria are set forth at 51 Federal Register 3624 (January 29, 1986). You also requested that we provide this opinion in time for your hearings scheduled for February 19, 1986. We have here set forth the major issues of legal concern, but in light of the time constraint, we did not solicit Energy's views.

In summary, we have concluded that Energy's proposed revised uranium enrichment services criteria are contrary to some basic and significant elements of the letter and legislative history of the statute governing the substantive requirements of the uranium enrichment program. Therefore, despite recognizing that economic circumstances of the enrichment market have changed and whatever the policy merits of Energy's proposal, it cannot legally be accomplished through rulemaking. We recommend that the policy changes reflected in Energy's proposed revised criteria be introduced in the form of a bill in the Congress and formally enacted before any further attempt is made to implement them.

More specifically, the primary substantive requirements of Energy's uranium enrichment program are set forth in subsection 161(v) of the Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2201(v). That provision prescribes, in relevant part, that:

1. "any prices established under this subsection shall be on a basis of recovery of the Government's costs over a reasonable period of time";

2. prices for services provided "shall be established on a nondiscriminatory basis";

3. Energy, "to the extent necessary to assure the maintenance of a viable domestic uranium industry, shall not offer such services for source or special nuclear materials of foreign origin intended for use in a utilization facility within or under the jurisdiction of the United States";

4. Energy "shall establish criteria in writing setting forth the terms and conditions under which services provided under this subsection shall be made available"; and

5. Before Energy establishes such criteria, the proposed criteria shall be submitted to the appropriate authorizing committees of the Congress, and a period of 45 days shall elapse while Congress is in session.

In addition, the reports of the Joint Committee on Atomic Energy accompanying the enacted subsection 161(v) set forth the Joint committee's view on the terms and conditions that should be included in the criteria: "Included among these 'terms and conditions' would be such matters as the charges for enrichment services, the conditions under which such services would be offered, and the general features of standard contracts for uranium enrichment services." H.R. Rep. No. 1702, 88th Cong., 2d Sess. 16 (1964); S. Rep. No. 1325, 88th Cong., 2d Sess. 16 (1964).

The proposed revised uranium enrichment services criteria and accompanying Supplementary Information are not consistent with the statute or the Joint Committee's advice in the following major respects:

1. The criteria provide that henceforth Energy's primary pricing objective of the enrichment program is maintenance of Energy's long-term competitive position,

a. relegating to a secondary objective the statutory requirement that the Government's costs be recovered over a reasonable period of time;

b. rejecting the concept of full cost recovery of the Government's investment, which had been implemented in practice for more than 15 years and had been endorsed by the Congress, Energy and its predecessor agencies, and GAO;

c. explicitly stating that Energy will not recover from customers in excess of $4 billion of prior Government investments in the program; and

d. asserting that the new standard for cost recovery is only "appropriate" Government costs, which Energy states will

only be those actually incurred in providing enrichment services to current civilian customers.

2. The criteria provide that prices will be individually negotiated, and they fail to set forth any fixed price or pricing mechanism, contrary to the Joint Committee's directive that "the charges for enrichment services" are to be set forth in the criteria.

3. The criteria fail to make provision for any standard contracts or to set forth the material general features to be contained in contracts, contrary to the Joint Committee's directive that the "general features of standard contracts for uranium enrichment services" are to be set forth in the criteria.

In addition, we have reservations about (1) whether the statutory requirement for assurance of nondiscrimination can be satisfied in practice if the proposed criteria are implemented as reflected in the Supplementary Information accompanying them, and (2) whether Energy has satisfied the statutory requirement regarding enrichment of uranium of foreign origin. This latter issue is currently being litigated before the U.S. District Court in Colorado.

COSTING

The proposed revised uranium enrichment services criteria are premised on the basis that the recovery of the Government's full costs of providing enrichment services is not required, and that "Congress granted [Energy] considerable discretion to determine, in the first instance, the best pricing approach and which costs are appropriate for recovery in an ever changing environment." 51 Fed. Reg. 3226 (January 29, 1986). We believe Energy is in legal error on this matter.

As you know, at the request of your subcommittee, we rendered a legal opinion (B-207463, December 27, 1984) in which we concluded that full cost recovery, including depreciation, was statutorily required after the 1970 amendment to subsection 161(v) of the Atomic Energy Act of 1954, 42 U.S.C.

§ 2201(v).[1] A copy of this opinion is enclosed for your convenience.

Footnote 5 to the Supplementary Information accompanying Energy's proposed criteria revisions specifically rejects this full cost recovery standard. In so doing, Energy relies extensively on the flexibility referred to in the 1964 legislative history when the Private Ownership of Special Nuclear Materials Act[2] was passed, adding subsection 161(v) to the Atomic Energy Act. The pricing standard provided in that act was admittedly the flexible one of "reasonable compensation to the Government." However, subsection 161(v) was amended in 1970[3] specifically to change the pricing standard to one of "recovery of the Government's costs over a reasonable period of time." It is the legislative history associated with the 1970 amendment that is now relevant and not that of the predecessor version of the statute.

As pages 6 and 7 of Appendix III to our December 27, 1984 legal opinion more fully explain, in the reports[4] of the Joint Committee on Atomic Energy associated with the 1970 amendment, the Joint Committee explicitly affirmed a GAO legal interpretation[5] of the meaning of subsection 161(v) as the Committee's intended meaning of the new statutory language

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1/ As is more fully explained in that opinion, there was one exception specifically provided for in the legislative history of the 1970 amendment; namely, where the Conway Excess Capacity Formula was applicable. However, this exception is no longer relevant, because the interim period in which the Conway Formula applied expired in 1976 when Energy exceeded 75 percent of production capacity from its gaseous diffusion plants.

2/ Public Law No. 88-489, approved August 26, 1964, 78 Stat. 603.

3/ Section 8 of Public Law No. 91-560, approved December 19, 1970, 84 Stat. 1472, 1474.

4/ H.R. Rep. No. 1470, 91st Cong., 2d Sess. 2 (1970); S. Rep. No. 1247, 91st Cong., 2d Sess. 2 (1970).

5/ B-159687, July 17, 1970 entitled Review of Proposed Revisions to the Price and Criteria for Uranium Enrichment Services, at 9, reprinted in Uranium Enrichment Pricing Criteria, 91st Cong., 2d Sess. 161-238 (June 16 and 17, 1970).

requiring "recovery of the Government's costs over a reasonable period of time." GAO's opinion required the recovery of costs in every instance except one, namely, the situation for which the Conway Formula had been devised to deal with the reduction or possible elimination of the military need for enriched uranium. Flexibility and consideration of the national interest were directed specifically and solely to this particular problem. As is explained in footnote 1 to this opinion, the interim period for which the Conway Formula applied expired in 1976 and is no longer relevant. Consequently, under the 1970 amendment to subsection 161(v) and its legislative history, full cost recovery is required.

GAO continues to believe that under existing statutory constraints, Energy does not have the legal flexibility to exclude unilaterally any government costs from its prices given the full cost recovery pricing requirement. The general tenor and a number of specific provisions of the proposed criteria contravene this legal requirement. For example, proposed 10 C.F.R. § 762.5 provides for recovery of only "appropriate" Government costs, with an implicit right reserved to Energy to determine what costs are appropriate. In this connection, Energy states in the Supplementary Information accompanying the proposed criteria revisions that:

> "The costs of items which are not, and most likely will not, be used in providing enrichment services to current civilian customers are not appropriate for consideration in determining the extent to which Government's costs are recovered over a reasonable period of time. [Energy] has determined that none of the costs of the Gas Centrifuge Plants and only forty percent of the costs of the Gaseous Diffusion Plants are used to provide enrichment services to civilian customers. Accordingly, only these latter costs are appropriate for determining the extent to which the Government's costs are recovered over a reasonable period of time."

51 Fed. Reg. 3628 and 3629 (January 29, 1986).

Our December 27, 1984, opinion addressed the legality of the exclusion from cost recovery and prices of the $1.2 billion of undepreciated value attributable to unused capacity of the gaseous diffusion plants. We held that this write-off for pricing purposes of undepreciated plant and capital equipment, so as to obviate the need for customer payments of related depreciation and imputed interest as part of the fee for

enriching services, violates the cost recovery requirement of subsection 161(v) of the Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2201(v). We have an open request from this subcommittee for a legal opinion on Energy's exclusion from current and future prices of its investment in the Gas Centrifuge Enrichment Plant (GCEP). We have formally requested of Energy any basis for its actions which would differentiate GCEP from our conclusions regarding the unused plant capacity of the gaseous diffusion plants. We have received no response from Energy, and we are aware of no distinguishing factors which would justify a different GAO result on the exclusion of GCEP costs from Energy's pricing formula.

These so-called write-offs result in a shifting of more than $4 billion of program costs from enrichment customers to the Government. This in effect constitutes a subsidization of the enrichment program in contravention of the Atomic Energy Act of 1954, as amended, and its legislative history. See Uranium Enrichment Service Criteria and Related Matters, Hearings Before the Joint Committee on Atomic Energy, 89th Cong., 2d Sess. 29, 33, 121, 319, 517 and 518 (August 2, 3, 4, 16 and 17, 1966).

We held in our December 27, 1984 legal opinion and still find that in order for enrichment program assets to be legally written-off and not recovered in the service price from customers, Congress must amend the Atomic Energy Act to authorize it. A criteria change will not suffice, since the criteria must be in accord with the statute.

PRICING

Proposed 10 C.F.R. § 762.4 provides:

"[Energy] shall negotiate prices in individual enrichment service contracts in accordance with an overall approach intended to maintain the long-term competitive position of [Energy] while obtaining the recovery of the Government's costs over a reasonable period of time."

51 Fed. Reg. 3631 (January 29, 1986). In addition, in the Supplementary Information accompanying the proposed revised criteria, Energy states that this "approach will permit [Energy] to pursue a vigorous program to regain market share." 51 Fed. Reg. 3628 (January 29, 1986). Elsewhere in that statement, Energy asserts that the Atomic Energy Act "does not mandate any particular form of pricing. Rather, it grants [Energy] considerable flexibility to determine what prices best achieve the objectives of [Atomic Energy Act], including

recovery of the Government's costs over a reasonable period of time." Id.

Whatever the policy merits of this proposed pricing approach of Energy, it is inconsistent with the Atomic Energy Act and its legislative history governing the substantive requirements of the uranium enrichment program.

Subsection 161(v) of the Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2201(v), provides that "any prices established under this subsection shall be on a basis of recovery of the Government's costs over a reasonable period of time." Moreover, the reports of the Joint Committee on Atomic Energy accompanying enactment of subsection 161(v) directed that "the charges for enrichment services" be set forth in the criteria. H.R. Rep. No. 1702, 88th Cong., 2d Sess. 16 (1964); S. Rep. No. 1325, 88th Cong., 2d Sess. 16 (1964).

Energy's proposed pricing approach chooses as primary pricing objectives of the program principles which are not referred to in the Atomic Energy Act or its legislative history--namely, the maintenance of Energy's long-term competitive position and pursuing a vigorous program to regain market share. On the other hand, it relegates to a secondary objective the primary statutory pricing requirement of obtaining the recovery of the Government's costs over a reasonable period of time. Moreover, the charges for enrichment services are not set forth in the proposed criteria as directed by the Joint Committee.6/ Rather, there is to be no fixed price or pricing mechanism. 51 Fed. Reg. 3628 (January 29, 1986).. Energy plans to negotiate prices in individual enrichment services contracts.

Energy's new pricing approach has no particular sanction in present law nor was it contemplated by the committees considering the legislation. Accordingly, whatever its policy merits, in our view, it should not be accomplished through rulemaking. This major reorientation of pricing policy and

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6/ We recognize that current enrichment service criteria also do not specify a particular price for enrichment services. See 44 Fed. Reg. 28875, 28876 (May 17, 1979). However, they provide for a pricing mechanism. They specify the costing elements to be included in the price, and were based on full recovery of the Government's costs and the prohibition on the making of a profit. Accordingly, the service charge or price was whatever was required to recover the listed costs over a reasonable period of time.

practice should only be legally accomplished by amendment of the Atomic Energy Act's pricing provisions.

OTHER TERMS

Subsection 161(v) of the Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2201(v), provides that Energy "should establish criteria in writing setting forth the terms and conditions under which [uranium enrichment] services provided under this subsection shall be made available." In addition, the reports of the Joint Committee on Atomic Energy accompanying the enacted subsection 161(v) state:

> "Included among these 'terms and conditions' would be such matters as the charges for enrichment services, the conditions under which such services would be offered, and the general features of standard contracts for uranium enrichment services." (Emphasis added.)

H.R. Rep. No. 1702, 88th Cong., 2d Sess. 16 (1964); S. Rep. No. 1325, 88th Cong., 2d Sess. 16 (1964).

In implementation of these requirements, the 1966 criteria specified two standard types of contracts--Firm Quantities Contracts and Requirements Contracts. The basic principles of each type were set forth along with the more significant provisions of the contracts. See 31 Fed. Reg. 16479 (December 23, 1966). Similarly, the criteria adopted in 1973 and, in large part, still effective today identified the Fixed Commitment Contract as its primary contracting vehicle and specifically set forth some new basic principles and concepts to be employed in the contracts. 38 Fed. Reg. 12180, 12181 (May 9, 1973) and 44 Fed. Reg. 28875 (May 17, 1979).

Moreover, current criteria include many guidelines on contract features in general terms, which must or may be included in Energy's uranium enrichment contracts in detail. Examples are provisions concerning advance contracting, fixed commitments, advance payments, delivery schedules, chemical form and specifications of feed material, the basis on which charges for enriching services will be calculated, the basis on which charges for termination by the customer will be calculated, delivery, transfer of title, and others.

Under Energy's proposed revised criteria, this practice will no longer be continued. Energy will have no standard contracts. Moreover, the proposed criteria contain virtually no significant general features to be contained in contracts.

Prices are to be individually negotiated, as are termination charges and other contractual provisions. In addition, Energy explicitly states that "a contract can contain terms and conditions not specified in the criteria. No prohibition against a term or condition is intended by its non-inclusion in the proposed criteria." 51 Fed. Reg. 3629 (January 29, 1986). The only restriction is that "the terms and conditions in a contract cannot be inconsistent with the criteria." See proposed 10 C.F.R. § 762.14.

The purpose of the statutory requirement that the terms and conditions under which enrichment services will be provided be established in published criteria and the directive of the Joint Committee on Atomic Energy that the charges for services and general features of standard contracts be set forth in the criteria was to enable the exercise of some congressional control over the content of uranium enrichment contracts and enrichment prices prior to their becoming effective, as well as facilitating congressional oversight. Energy's proposed revised criteria severely limit all of these objectives. When Energy's predecessor (the Atomic Energy Commission) proposed very general criteria in 1973 excluding some of these elements, they were rejected by the Joint Committee on Atomic Energy. Several examples of statements made by committee members at that time are illustrative of their reaction:

1. "Senator Jackson. * * * the revised criteria omit any reference to the types and significant details of the contracts under which enrichment services will be provided." Proposed Changes in AEC Contract Arrangements for Uranium Enriching Services, Hearings Before the Subcommittee on Energy, Joint Committee on Atomic Energy, 93rd Cong., 1st Sess. 2 (March 7, 8, 26; and April 18, 1973).

2. "Representative Price. Since the significant features of the new types of contracts are not described in the criteria there appears to be nothing that would require the Commission to return to the Joint Committee should it decide to vary the terms and conditions under which it would provide the uranium enrichment services. This seems to be a substantial departure from the intent of section 161(v) * * *." Id., at 32.

3. "Representative Holifield. * * * What control do you feel the Joint Committee will have over the essential terms and conditions of this or any other contract for enriching services under the new criteria?

"Mr. Allen [President, Yankee Atomic Electric Co., and Vice President, New England Electric System]. None.

"Representative Holifield. Thank you. I came to the same conclusion. * * * The new criteria would eliminate any supervision of this committee over these things." Id., at 83.

We believe that the failure of Energy's proposed revised criteria to provide for standard contracts and to set forth their material general features is contrary to the intended structure and operation of the uranium enrichment program as reflected in the Atomic Energy Act and its legislative history.

NONDISCRIMINATION

Subsection 161(v) of the Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2201(v), requires that prices for enrichment services "shall be established on a nondiscriminatory basis." Proposed 10 C.F.R. § 762.7 provides:

"The same prices, as well as other terms and conditions, shall be available to all similarly-situated customers on a nondiscriminatory basis, reflecting the cost of the enrichment services supplied to those customers."

Although the language of this proposed nondiscrimination criterion refers to the statutory language, we have reservations whether the statutory standard can be satisfied in practice if the proposed criterion is implemented as reflected in Energy's Supplementary Information and the other proposed criteria.

Energy's proposed revised criteria provide that it will negotiate price, as well as other terms and conditions of a contract. Not only will there be no fixed price, but no fixed price mechanism. There will be no standard contracts. Similarly, there need not be standardized terms and conditions for other aspects of a contract. Despite these circumstances, Energy states in the Supplementary Information accompanying the

proposed criteria provisions that the statutory nondiscrimination provision means that "all customers * * * be afforded an opportunity to strike a bargain equal in attractiveness to those available to other customers." 51 Fed. Reg. 3629 (January 29, 1986). However, no provision is made in the criteria for disclosure of pricing and other contracting information to other customers when a particular contract is entered into.

In these circumstances, we have reservations whether the proposed criterion provision will assure in implementation the nondiscriminatory treatment required by the statute. This is a very different factual situation from that existing previously, when there were standard contracts, general features contained in these contracts, and a published price for services available to all customers.

CONCLUSION

For the above reasons, we have concluded that Energy's proposed revised uranium enrichment services criteria are contrary to the letter and legislative history of the statute governing the substantive requirements of the uranium enrichment program. Consequently, they cannot be legally accomplished through rulemaking, whatever their policy merits. We recommend that, if Energy wishes to continue to pursue the policy initiatives reflected in these proposed criteria revisions, these policy changes be introduced in the form of a bill in Congress and formally enacted before any further attempt is made to implement them.

Notwithstanding these conclusions, it must be recognized that the current market situation with regard to the sale of uranuim enrichment services is far different from conditions which prevailed at the time the full cost recovery requirement was enacted. As we have stated on a number of occasions in the past, there is a compelling need, because of the market changes and constraints imposed by full cost recovery pricing in the current market environment, for the executive branch and the Congress together to reexamine the fundamental purpose and structure of the uranium enrichment program.

Sincerely yours,

Milton J. Socolar

Acting Comptroller General
of the United States

Enclosure

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202/662-5394

FOR IMMEDIATE RELEASE

Washington, D.C., February 11, 1986 -- The Uranium Producers of America (UPA) believe that the Department of Energy's proposed new enrichment criteria violate the explicit legal requirements of the Atomic Energy Act. Section 161(v) of the Act requires DOE to restrict enrichment of foreign-source uranium to the extent necessary to preserve the viability of the domestic uranium industry. In September 1985, Secretary of Energy Herrington determined that the industry was non-viable. According to UPA, massive and ever-increasing imports of low-priced, government-subsidized nuclear source materials are a primary cause of the domestic industry's problems. Nonetheless, says UPA, the Department of Energy would continue to make its enrichment services freely available to foreign-source uranium to the continuing detriment of the U.S. industry -- despite DOE's explicit legal obligation to the contrary.

The changes DOE has proposed to make in its enrichment criteria appear designed, claims UPA, solely to enhance its own competitive position as a provider of

- more -

enrichment services and to bypass Judge Carrigan's ruling in September 1985 that the DOE's enrichment contract promulgated pursuant to existing enrichment criteria is null and void. DOE has already filed a request with the 10th Circuit Court of Appeals to forestall further review of Judge Carrigan's determination on the ground that its proposed new criteria moot that decision. UPA believes that any proposed enrichment criteria that do not include restrictions on the enrichment of foreign-source nuclear material are illegal, and will oppose any DOE attempt to block further judicial consideration of the matter.

DOE's actions reflect a narrowly-focused preoccupation with the profitability of its enrichment enterprise to the exclusion of considerations affecting the viability of the domestic uranium industry, according to UPA. If DOE follows its present course, UPA warns, the United States may become <u>entirely</u> dependent on foreign sources of uranium supply, a possibility with significant implications not only for the U.S. economy and the goal of energy independence, but also for national security.

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UNITED STATES GENERAL ACCOUNTING OFFICE

WASHINGTON, D.C.

FOR RELEASE ON DELIVERY
EXPECTED AT 2:00 P.M.
FEBRUARY 19, 1986

STATEMENT OF

J. DEXTER PEACH

DIRECTOR, RESOURCES, COMMUNITY, AND ECONOMIC DEVELOPMENT DIVISION

BEFORE THE

SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER

HOUSE COMMITTEE ON ENERGY AND COMMERCE

ON

THE U.S. URANIUM ENRICHMENT SERVICES PROGRAM

Mr. Chairman and members of the Subcommittee, we appreciate this opportunity to present our views on the status of the U.S. uranium enrichment program. At your request, we previously provided you with a copy of testimony that we prepared for the December 11, 1985, hearing which was postponed until today. I request that our earlier statement also be included in the hearing record.

Our earlier testimony emphasized our consistent position in recent years that the Congress and the executive branch need to reevaluate the basic purpose and structure of the enrichment program. We believe any reevaluation must include

--defining program objectives that take into account the realities of the enrichment market place,

--examining alternatives to full-cost-recovery pricing that provide the Department of Energy (DOE) greater flexibility to compete in today's environment, and

--agreeing on the amount of unrecovered government enrichment costs to be repaid to the Treasury.

Our testimony also pointed out that the government's unrecovered enrichment costs at September 30, 1984, amounted to $7.3 billion.

On January 29, 1986, DOE released a proposed modification of the Uranium Enrichment Services Criteria (criteria), or the rules under which DOE provides uranium enrichment services. DOE's proposal represents a major redirection of program emphasis away from full cost recovery and standard contractual terms to increased emphasis on competition, recovery of less than all of the government's costs, and individually tailored contract terms and conditions. To the extent that these modifications represent the administration's view on the appropriate enrichment program objectives and structure for today's enrichment environment, they are a first step in facilitating the program reevaluation we have consistently called for in earlier reports and testimonies. We do, however, have concerns about:

--the appropriateness of using modifications to the criteria to make major program changes as opposed to a legislative proposal and the related implications for the effectiveness of congressional involvement in the change process.

--areas where the proposed criteria modifications in our view are in conflict with basic statutory requirements, and

--possible limitations on future congressional oversight of the enrichment program if the criteria are adopted.

PERSPECTIVE ON THE ENRICHMENT PROGRAM

Let me again place in perspective the dilemma faced by DOE in managing the enrichment program. Today's uranium enrichment market is considerably different from the one that existed at the time the full-cost-recovery requirement for the U.S. program was established. Lower prospects for growth in the nuclear power industry coupled with foreign competition, the emergence of a secondary market for enriched uranium, and prices that were the highest in the world led to a steady deterioration of the program's competitive position. This environment is described in our December 11, 1985, statement.

To help curtail the continuing deterioration of its market share, DOE has taken a number of initiatives that have affected the repayment of the government's unrecovered enrichment costs. For example, in fiscal year 1984, DOE wrote off $1.2 billion of the remaining unrecovered government costs in the gaseous diffusion enrichment facilities. DOE estimated that this action lowered its enrichment price by about $10 per unit.

As indicated in our past reports and testimonies, some of DOE's initiatives to make the U.S. program competitive conflict with our interpretation of the cost recovery requirement stated in the enrichment program's governing statute--subsection 161(v) of the Atomic Energy Act of 1954, as amended. DOE maintains that the statute provides it discretion to determine which government enrichment costs should be recovered. Our position is that, absent a statute change, DOE does not have the flexibility to unilaterally exclude certain government costs--particularly capital investment costs--from its prices.

Because of the conflict between DOE's initiatives and our interpretation of the act, we have suggested that the executive branch and the Congress need to reevaluate the fundamental purpose and structure of the uranium enrichment program. Recent DOE decisions have intensified this need. For example, DOE decided not to include in its enrichment price, and thus not recover, the government's $2.8 billion in costs associated with the construction of the recently terminated gas centrifuge enrichment facility at Portsmouth, Ohio.

In preparing a criteria change, DOE states its belief that the existing criteria do not provide the basis to compete in today's marketplace. In essence, DOE's proposal represents its current view of the basic objectives of the enrichment program and how it should be structured to compete in today's enrichment market.

With this backdrop, let me briefly elaborate on our concerns with the criteria changes proposed by DOE.

APPROPRIATENESS OF USING A CRITERIA REVISION

In our view, legislation amending the Atomic Energy Act, rather than modification of the criteria, is the correct approach for effecting change in the uranium enrichment program of the scope embodied in DOE's proposed criteria. Moreover, we believe that aspects of the proposed criteria, which I will discuss in more detail in a moment, are in conflict with the program's governing statute.

The proposed criteria would, if implemented, result in a major redirection of the uranium enrichment program involving the writeoff of government assets and basic changes in DOE's approach for determining its costs and for negotiating enrichment services contract terms and prices. However, we are concerned that the process set out in the act for making criteria changes--submitting the changes to authorizing committees of the Congress for 45 days before they take effect--does not provide the Congress with a sufficient opportunity to review changes of this magnitude and explore alternatives to them.

In effect, this process requires the Congress to either accept DOE's proposed criteria modifications or to pass legislation prohibiting DOE from implementing them. Thus, for all practical purposes, DOE's use of a criteria revision to change basic program objectives serves to limit effective congressional participation in the reevaluation of the uranium enrichment program.

LEGALITY OF THE PROPOSED CRITERIA

There are three provisions in the proposed criteria that conflict with the statutory requirements governing the enrichment program. In addition, with respect to one other provision, we are concerned whether DOE can satisfy the requirements of the act. Pursuant to your request, we are providing a legal analysis of the proposed criteria which discusses these areas in detail.

First, the act requires DOE to recover the government's costs of providing enrichment services over a reasonable period of time. The proposed criteria, on the other hand, state that DOE

will collect and repay to the Treasury about $3.5 billion of what DOE estimates is $7.5 billion in unrecovered government costs as of the end of fiscal year 1985. The remaining $4 billion, which basically consists of the investment in the gas centrifuge project and most of the undepreciated portion of the gaseous diffusion plants, would not be recovered. As we advised you in our December 27, 1984, legal opinion, a criteria change by itself does not provide, in our view, sufficient legal grounds for not recovering government enrichment costs from customers.

Second, the proposal defines costs to be recovered through charges for enrichment services as "appropriate government costs to the extent they reasonably relate to providing enrichment services to civilian customers." This permits DOE to determine that some government enrichment costs are not appropriate for recovery. Thus, it is inconsistent with the full cost recovery requirement now embodied in the Atomic Energy Act.

Third, the act requires DOE to set out in written criteria the terms and conditions under which it will provide enrichment services. In establishing this requirement, congressional committee reports stated that the "general features of standard contracts for uranium enrichment services" were to be set forth in the criteria. DOE's proposed criteria, however, do not do this. Rather, it permits the department to tailor each contract to the customer's needs, which could, in effect, eliminate the standardization which Congress intended.

Finally, the act requires DOE to establish prices for domestic customers on a nondiscriminatory basis. In this regard,

DOE's proposed criteria state that it will not discriminate. However, the criteria also provides that DOE will negotiate prices and other contract terms and conditions with individual customers. Traditionally, one basic price has been available to all customers with the same contract type. Therefore, we have reservations whether the requirement of the act can be satisfied in practice if the criteria are implemented.

EFFECT ON CONGRESSIONAL OVERSIGHT

Over the years congressional oversight has been an important part of the uranium enrichment program. While DOE's proposed criteria, if implemented, would obviously not preclude congressional oversight, the proposal as written makes oversight difficult. The proposed criteria have been written in a manner that provide DOE maximum flexibility to operate the enrichment program, and they have few feedback provisions or accountability measures.

As I discussed earlier, for example, DOE would negotiate contract terms and prices on a customer-by-customer basis, prices would no longer be directly tied to recovery of the government's enrichment costs, and DOE would reserve to itself the prerogative of determining what government costs are appropriate for recovery through its prices.

Given this flexibility, benchmarks that have been useful in the past to monitor the program, such as a clear definition of what costs should be recovered, how prices will be determined, and the general approach to contract terms, would be removed.

Moreover, it is entirely possible that DOE would never again have to propose criteria changes and lay them before the Congress for review.

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In closing, Mr. Chairman, let me make several points. DOE's proposed criteria revision does serve a useful purpose in that it places in the public record DOE's objectives for the program, the flexibility it believes is needed to allow it to compete in the world marketplace, and a clear position on the amount of unrecovered government costs that it plans to recover from future program revenues. We have consistently stated that these issues need to be considered in any reevaluation of the uranium enrichment program.

As our testimony today states, we believe that program changes involving such a major redirection of the uranium enrichment program should be accomplished by legislative changes with criteria subsequently developed that flow logically from and are consistent with the legislation. In our testimony, we have highlighted areas where we believe the proposed criteria are in conflict with existing legislation and could possibly limit effective congressional oversight.

The criteria, of course, may be revised as DOE goes through its rulemaking process. Also, Congress may act based on concerns it has with the criteria. If DOE continues on its present course and completes its rulemaking process and allows the criteria as revised to lay before the Congress for 45 days, and if the Congress, having been made aware of DOE's criteria revisions and

our concerns, takes no action to require change of the criteria, it would be difficult for GAO to raise objections about future DOE actions that are consistent with the revised criteria, absent further legislative direction by the Congress.

Mr. Chairman, this concludes my prepared remarks. I will be happy to respond to any questions at this time.

March 14, 1986

EXPLANATION OF FINANCIAL PLAN CHANGES
OPERATING EXPENSES (COSTS)
APPROPRIATION: Uranium Enrichment
PROGRAM: Uranium Enrichment Activities (CD 10)

FY 1986

	Present Plan 89X0226	Proposed Plan 89X0226	Proposed Change 89X0226
Gaseous Diffusion Operations and Support			
Diffusion Cascade Power	$ 884,300,000	$ 884,300,000	$ 0
Diffusion Operations	114,134,207	114,134,207	0
Recovery of Diffusion Scrap	3,000,000	3,000,000	0
Process and Long Range Technical Support	13,400,000	13,400,000	0
Supporting Services-UESA	36,388,774	36,388,774	0
Supporting Services-Non UESA	4,057,019	4,057,019	0
Change in Inventories	0	0	0
Cost of Work for Others	6,320,000	6,320,000	0
Subtotal, Gaseous Diffusion Operations and Support	1,061,600,000	1,061,600,000	0
Enrichment Research and Development			
Gas Centrifuge Operations and Support			
Gas Centrifuge Process Development and Demonstration	39,600,000	39,600,000	0
Support and Special Studies	0	0	0
Subtotal, Centrifuge	39,600,000	39,600,000	0
Atomic Vapor Laser Isotope Separation AVLIS	114,000,000	114,000,000 1/	0
Supporting Technology and Analysis	0	0	0
Subtotal, AVLIS	114,000,000	114,000,000	0
Total, Enrichment R&D	153,600,000	153,600,000	0
Program Direction - UEA			
Personal Services	3,321,000	3,321,000	0
Personnel Benefits	372,000	372,000	0
Travel and Transportation of Persons	705,000	705,000	0
Contractual Services and Supplies	402,000	402,000	0
Subtotal, Program Direction - UEA	4,800,000	4,800,000	0
Gas Centrifuge Enrichment Plant (GCEP)			
Gas Centrifuge Operations	9,000,000	9,000,000	0
Supporting Services	0	0	0
Subtotal, GCEP	9,000,000	9,000,000	0
Total Uranium Enrichment Activities	$1,229,000,000	$1,229,000,000	$ 0
Summary by Office			
Oak Ridge/TIC	$ 665	$ 665	$ 0
Oak Ridge/ORNL	192,000	282,000	+90,000
Oak Ridge Operations Office	1,081,430,550	1,081,430,550	0
Headquarters, DAS/UE	88,214,042	88,124,042	-90,000
SAN/LLNL	28,200,000	42,600,000	+14,400,000
Albuquerque Operations Office	491	491	0
Albuquerque/LANL	33,660	33,660	0
Chicago/ANL	91,178	91,178	0
Chicago Operations Office	10,000	10,000	0
San Francisco Operations Office	30,367,050	15,967,050	-14,400,000
Richland Operations Office/PNL	100,364	100,364	0
Richland Operations Office/HEDL	13,000	13,000	0
Headquarters/EIA	0	0	0
Headquarters/EN	197,000	197,000	0
Idaho Operations	$ 150,000	$ 150,000	$ 0
Total Uranium Enrichment Activities	$1,229,000,000	$1,229,000,000	$ 0

1/ Includes $1,370,750 for S.B.I.R.

March 14, 1986

EXPLANATION OF FINANCIAL PLAN CHANGES

OPERATING EXPENSES (OBLIGATIONS) FY 1986
APPROPRIATION: Uranium Enrichment
PROGRAM: Uranium Enrichment Activities (CD 10)

	Present Plan 89X0226	Proposed Plan 89X0226	Proposed Change 89X0226
Gaseous Diffusion Operations & Support			
New FY 1986 Authority	$1,084,448,000	$ 1,084,448,000	$ 0
FY 1985 Unobligated Carryover	2,112,436	2,112,436	0
Subtotal, Diffusion	1,086,560,436	1,086,560,436	0
Enrichment Research and Development			
Centrifuge Development			
New FY 1986 Authority	18,000,000	18,000,000	0
FY 1985 Unobligated Carryover	41,818	41,818	0
Subtotal, Centrifuge Development	18,041,818	18,041,818	0
AVLIS			
New FY 1986 Authority	114,000,000	114,000,000 1/	0
FY 1985 Unobligated Carryover	9,173	9,173	0
Subtotal, AVLIS	114,009,173	114,009,173	0
Subtotal, Enrichment R&D	132,050,991	132,050,991	0
Program Direction - UEA			
New FY 1986 Authority	4,400,000	4,400,000	0
FY 1985 Unobligated Carryover	807,953	807,953	0
Subtotal, Program Direction	5,207,953	5,207,953	0
Gas Centrifuge Enrichment Plant			
New FY 1986 Authority	0	0	0
FY 1985 Unobligated Carryover	20,779	20,779	0
Subtotal, GCEP	20,779	20,779	0
Total, Uranium Enrichment Activities	$1,223,840,159	$ 1,223,840,159	$ 0
Summary by Office			
Oak Ridge Operations Office	$ 928,989,019	$ 928,989,019	$ 0
Headquarters, DAS/UE	8,588,829	8,498,829	-90,000
DOE Reserves (SBIR)	1,370,750	1,370,750	0
OMB Reserve	149,401,000	149,401,000 2/	0
DOE Reserves	46,729,000	46,729,000 3/	0
SAN/LLNL	36,900,000	54,400,000	+17,500,000
Albuquerque/LANL	30,000	30,000	0
Albuquerque/SNL	0	0	0
Chicago/ANL	74,000	74,000	0
Chicago Operations Office	0	0	0
San Francisco Operations Office	51,324,561	33,824,561	-17,500,000
Richland/PNL	56,000	56,000	0
Richland/HEDL	13,000	13,000	0
Oak Ridge/ORNL	167,000	257,000	+90,000
Oak Ridge/TIC	0	0	0
Chicago/BNL	0	0	0
Headquarters/EIA	0	0	0
Headquarters/EN	$ 197,000	$ 197,000	$ 0
Total, Uranium Enrichment Activities	$1,223,840,159	$ 1,223,840,159	$ 0

1/ Includes $1,370,750 for SBIR.
2/ FY 1987 deferral and excludes a $152,000 reduction in consultant services
3/ Includes $46,479,000 G-R-H sequester.

March 14, 1986

Explanation of Changes:

Operating Expenses

This Financial Plan change: 1) transfers $90,000 in obligations and cost from ASNE (CD 10-01-23-2) for several new ASNE support projects (tasks) at ORNL and; 2) transfers $17,500,000 in obligations and $14,400,000 in costs from SAN to LLNL for FY 1986 third quarter AVLIS activities.

Equipment

This Financial Plan change transfers $3,000,000 obligations from NE to LLNL for FY 1986 third quarter AVLIS support.

Construction

This Financial Plan change transfers $586,000 obligations from NE to LLNL for FY 1986 third quarter AVLIS support.

Released

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

RESOURCES, COMMUNITY, AND ECONOMIC DEVELOPMENT DIVISION

August 10, 1984

B-207463

The Honorable John D. Dingell
Chairman, Committee on Energy
and Commerce
House of Representatives

The Honorable Richard L. Ottinger
Chairman, Subcommittee on Energy
Conservation and Power
Committee on Energy and Commerce
House of Representatives

Subject: Information on Repayment of the Government's Uranium Enrichment Program Costs and Audits of That Program's Financial Statements (GAO/RCED-84-190)

Your letter of June 4, 1984, raised a series of questions about the Department of Energy's (DOE's) Uranium Enrichment Program activities. You asked that we obtain information concerning DOE's repayment of the government's enrichment program costs; audits of the program's financial statements; current and future financial status of the program; new and advanced enrichment technology construction, development, and selection; and legal issues concerning the execution of statutory requirements. This letter responds to your questions concerning repayment of the government's enrichment program costs and audits of the program's financial statements. As agreed with your respective offices, we plan to respond to your other questions at a future date.

The remainder of this letter includes the objective, scope, and methodology of our work; an overview of DOE's Uranium Enrichment Program; and our responses to your specific questions.

OBJECTIVE, SCOPE, AND METHODOLOGY

To answer your questions concerning the repayment of the government's enrichment program costs and audits of the program's financial statements, we interviewed program officials at DOE's Office of Uranium Enrichment in Germantown, Maryland. We also obtained information from the program's financial statements, audit reports on those statements, appropriations and budget documents, the program's authorizing legislation, and the

(301671)

Uranium Enrichment Services Criteria.[1] To respond to your repayment questions, we interviewed an official from DOE's Office of Budget in Germantown and an official from the Department of the Treasury's Bureau of Government Financial Operations in Washington, D.C. To answer the financial statement questions, we used GAO's Standards for Audit of Governmental Organizations, Programs, Activities, and Functions[2] as a guide, and interviewed officials from DOE's Division of Finance, the Office of Performance Evaluation, and the Office of the Inspector General at DOE's Oak Ridge Operations Office in Oak Ridge, Tennessee. Because fiscal year 1971 was the first year that DOE published financial statements for this program, we used that year's financial statements as the base for developing information to respond to your questions. However, we did not verify the accuracy of data contained in DOE's annual financial statements or historical appropriations data that program officials provided us.

We did not obtain official agency comments on this report; however, we discussed the information contained in the report with DOE program officials. Our audit work was primarily carried out during June and July of 1984. Except as noted above, we performed our work in accordance with generally accepted government auditing standards.

OVERVIEW OF DOE'S URANIUM ENRICHMENT PROGRAM

Uranium enrichment is a process used to increase the concentration of the fissionable uranium-235 isotope found in natural uranium to the levels required for the uranium to be used in various applications. Since 1969, the federal government--through the former Atomic Energy Commission, the former Energy Research and Development Administration, and now DOE--has operated enrichment plants primarily to enrich uranium for fuel in its customers' domestic and foreign nuclear power reactors.[3]

DOE's existing uranium enrichment capacity consists of three plants located at Paducah, Kentucky; Portsmouth, Ohio; and Oak Ridge, Tennessee. These plants use an energy-intensive uranium enrichment technology known as "gaseous diffusion" and have the

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[1]The Atomic Energy Act of 1954, as amended (42 U.S.C. 2201(v)), requires DOE to establish criteria setting forth the terms and conditions under which enrichment services are to be provided. Such terms and conditions are embodied in a document entitled Uranium Enrichment Services Criteria.

[2]By the Comptroller General of the United States, revised Feb. 27, 1981.

[3]DOE's plants also provide enriched uranium for research and defense applications.

capacity to produce about 27 million separative work units[4] of enriched uranium per year. In addition to the gaseous diffusion plants, DOE is building a new enrichment facility in Portsmouth, Ohio, that will use a different enrichment technology, known as "gas centrifuge." DOE believes that because the gas centrifuge facility will require significantly less electricity to operate, it will be able to enrich uranium more cheaply and, therefore, be able to lower overall enrichment costs and prices. DOE is also developing two other enrichment technologies--advanced gas centrifuge and atomic vapor laser isotope separation--which, according to DOE, have the potential of reducing enrichment costs and prices to a level substantially below that possible from either the existing gaseous diffusion plants or initial production from the gas centrifuge facility now under construction. If successful, DOE expects to utilize one or both of these advanced technologies for producing enriched uranium beginning in the late 1980's to the early 1990's.

In providing enrichment services to its customers, DOE is required under Section 161(v) of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2201(v)), to price such services so that the government's enrichment costs will be recovered over a ". . . reasonable period of time." Ten years was initially established by DOE as being a reasonable period, and over the years it has been accepted as such by cognizant congressional committees. Thus, until recently, enrichment prices had been adjusted annually by DOE to reflect its projected costs of providing enrichment services over the ensuing 10-year period. Currently, however, DOE is offering a new contract that contains a guaranteed 10-year enrichment services ceiling price which will be adjusted annually for increases in electric power costs to produce the enriched uranium and inflation.[5]

To satisfy its cost recovery requirement, DOE's enrichment price has included both appropriated program costs and imputed

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[4]The capacity of plants used for producing enriched uranium is defined in terms of separative work units. Such units measure the amount of effort expended to separate a given amount of natural uranium into two components--one having a higher concentration of fissionable uranium-235.

[5]DOE's guaranteed ceiling price was discussed in our report, Information on DOE's Costing and Pricing of Uranium Enrichment Services (GAO/RCED-84-156, Apr. 25, 1984).

interest.[6] At the end of fiscal year 1971, the unrecovered government costs[7] were about $1.4 billion. Between fiscal years 1971 and 1983, DOE and its predecessor agencies received appropriations of about $13 billion for the enrichment program's operations and capital investments, and imputed about $3.6 billion in interest expense. Thus, from fiscal year 1971 through the end of fiscal year 1983, the total amount of government costs subject to the program's cost recovery requirement, including the unrecovered balance at the end of fiscal year 1971, has been about $18 billion. According to the enrichment program's financial statements, the government had recovered about $12 billion of these costs, thus leaving an unrecovered balance of about $6 billion as of the end of fiscal year 1983.

While the remainder of this letter contains our responses to your questions, it is important that they be viewed within the context of the fundamental problems which have developed over the last several years for the uranium enrichment program. The market environment in which DOE's program must operate today is considerably different from the one existing at the time the cost recovery requirement for DOE's program was established. The lower prospects for growth in the nuclear power industry coupled with foreign competition and the emergence of a secondary market for enriched uranium are all affecting the program. With prices that in the past few years have been the highest in the world, the program's competitive position has been steadily deteriorating.

We continue to hold to the view expressed in our March 1, 1984, testimony before the Subcommittee on Energy Conservation and Power, House Committee on Energy and Commerce, that the executive branch together with the Congress needs to reexamine the fundamental purpose and structure of the uranium enrichment program. Such a reexamination must consider our nation's objective for serving the domestic and international uranium

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[6]Imputed interest is an interest cost assigned to a particular inhouse government investment alternative representing the cost of U.S. Treasury borrowings. Actual interest expenditures may not be incurred by the individual agency undertaking the activity. However, since the money used in the activity is not available to the Treasury for alternative programs, the Treasury resorts to borrowed funds and, in the process, incurs an interest expense.

[7]The government's costs for this program are defined in the Uranium Enrichment Services Criteria. The Criteria define the components that are included in the cost of separative work. The components include: electric power, other operating costs, depreciation, imputed interest on the unrecovered government investment, and other costs incurred in providing enrichment services, such as DOE administrative costs and enrichment plant security costs.

enrichment markets and provide adequate flexibility in pricing policies to allow effective competition with foreign suppliers.

QUESTIONS ABOUT THE GOVERNMENT'S URANIUM ENRICHMENT PROGRAM COSTS

Question: Has the Department received direct appropriations since the inception of the program to finance any of its programs, for example, the Cascade Improvement Program and the Cascade Uprating Program? If so, (1) specify each year and the amount of funds directly appropriated to the program, (2) specify any payment made by the Department to the federal Treasury to offset such appropriations. (Item (2) of this question is addressed in the response to the next question.)

GAO response

The enrichment program's operating expenses and capital investments have been and continue to be funded with appropriations. For fiscal years 1972 through 1978, the program's operating costs were funded as part of DOE's and its predecessor agencies' annual appropriations for agencywide operating expenses. This agencywide appropriation included specific dollar amounts and revenues generated from the sale of enriched uranium and from other agency programs. Thus, the revenues generated by the enrichment program became part of the total appropriation amounts available to fund agencywide operations, and were not specifically designated for the sole use of the enrichment program. In addition, the enrichment program received funds for capital investments as part of a separate agencywide appropriation for plant and capital equipment.

For fiscal years 1979 and 1980, the Congress appropriated funds specifically for uranium supply and enrichment activities, thus separating uranium enrichment appropriations from those of the rest of the agency. During this period, revenues were added to the amount appropriated for the enrichment program. However, beginning with fiscal year 1981, monies received from the sale of enrichment services were no longer included in the appropriation amount. Instead, the appropriation acts required the monies received from the sale of enrichment services to be used to offset enrichment program appropriations.

For fiscal year 1985, the Congress indicated that it expects enrichment appropriations of about $1.7 billion will be offset by DOE-estimated revenues of the same amount. However, although the revenues are to be used to "offset" appropriations, the program is

entitled to obligate funds up to the appropriated amount, even if program costs exceed the revenues received from enrichment sales. The fiscal year 1985 conference report[8] states that

> ". . . The conferees intend that the executive branch obligate each year the full amount as contained in the annual Appropriations Act in order to operate the enrichment enterprise at the level and in the manner provided for in the appropriation. The conferees recognize that actual revenues will often differ from the estimates made at the time the appropriations are arrived at. In the event revenues fall short of estimates, the conferees intend that obligations not be constrained to match revised estimates. Rather obligations are to be consistent with the levels contained in the annual Appropriations Act . . . ."

Should monies received exceed the appropriation amount, the excess could not automatically become available for expenditure on program activities. Instead, the excess funds are required to be returned to the Treasury's miscellaneous receipts account in accordance with 31 U.S.C. 3302.

The following chart shows the appropriation amounts by major uranium enrichment activities, including the Cascade Improvement and Uprating Programs[9] and the gas centrifuge facility, from fiscal years 1972 through 1983.

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[8]H.R. Rep. No. 866, 98th Congress, 54 (June 26, 1984).

[9]The Cascade Improvement and Uprating Programs, completed in fiscal year 1983, have increased the capacity of the original gaseous diffusion plants by about 60 percent to about 27 million separative work units per year and have increased plant efficiency so that the power required to produce each unit has been decreased.

Appropriations by Major Uranium Enrichment Activities
From Fiscal Year 1972 to Fiscal Year 1983

Fiscal year	Operating and other costs	Cascade Improvement and Uprating Programs	Gas centrifuge facility	Total
	(in millions)			
1972	$ 196.4	$ 25.0	$ —	$ 221.4[a]
1973	242.5	25.0	—	267.5[a]
1974	110.0	121.7	—	231.7[a]
1975	466.2	162.4	—	628.6
1976	496.9	345.5	12.6	855.0
1977	1,018.8	428.8	167.3	1,614.9
1978	1,097.4	207.7	150.0	1,455.1
1979	1,037.7	97.0	150.0	1,284.7
1980	973.3	64.6	322.7	1,360.6
1981	1,313.8	—	149.2	1,463.0
1982	1,218.0	—	588.0	1,806.0
1983	1,246.1	—	598.0	1,834.1
Total	$9,417.1	$1,477.7[b]	$2,127.8	$13,022.6

[a]The appropriation amounts for fiscal years 1972-74 were obtained from the enrichment program's financial statements because DOE was unable to provide budget records for these years. According to DOE program officials, these amounts reasonably represent the actual appropriations for those years.

[b]In addition to this amount, the Congress appropriated about $21.1 million in fiscal year 1971 for the Cascade Improvement and Uprating Programs.

Source: Prepared by GAO using data provided by DOE's Office of Uranium Enrichment.

B-207463

Question: Does the Department have a formal plan to repay to the Treasury any of the government's prior cost of investment in the program? If so, please evaluate the adequacy of the plan to meet the statutory requirement. If not, and if no or insufficient repayments have in fact occurred during the 14 years of the program's existence, is the Department in compliance with Section 161(v) of the Atomic Energy Act of 1954, as amended?

GAO response

DOE is not required to have a formal plan for repaying the Treasury for the government's cost of providing uranium enrichment services, nor does the legislative history indicate that the Congress intended the program to make specific repayments to the Treasury as is the case for some other programs.[10] DOE is, however, required by the Atomic Energy Act of 1954, as amended, to recover the government's costs of providing enrichment services. These recovered costs have not been used by DOE to repay the Treasury but, as explained in the answer to the previous question, have been designated by the Congress either for use as part of actual appropriations or to offset appropriations. Therefore, the specific use of the revenues has been governed by language contained in appropriations acts and not left to the discretion of program or agency officials. According to the enrichment program's financial statements, DOE has recovered, through the price it charges its customers for enrichment services, about $12 billion[11] of the approximately $18 billion in government costs subject to the program's cost recovery requirement, thus leaving an unrecovered balance of about $6 billion as of the end of fiscal year 1983.

The Deputy Assistant Secretary for Uranium Enrichment told us that although DOE has no formal plan to repay the Treasury for the unrecovered government cost in the enrichment program, DOE considers the repayment of this amount a program objective. He

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[10]The Bonneville Power Administration is an example of a program required to pay back the government's investment through specific repayment to the Treasury. The Bonneville Project Act of 1937 created the Bonneville Power Administration and authorized it to market power from federal dams; construct and operate transmission facilities; encourage widespread use of electricity; and set rates to recover the cost of generation, transmission, and investment. This act and subsequent legislation require Bonneville to repay the federal investment in power-generating facilities and set electric power rates at the lowest possible level consistent with sound business practices.

[11]A schedule showing the program's annual revenues from fiscal years 1972 through 1983 is contained in the enclosure to this letter.

said that at some yet unknown time, the enrichment sales price is expected to generate program revenues that exceed expenditures, and the remaining unrecovered government cost will then begin to be reduced and eventually eliminated. We should point out that this may take quite some time to accomplish if DOE continues with its planned construction of the $6.5-billion gas centrifuge facility or makes other capital-intensive expenditures, since these funds are spent faster than they are recovered through depreciation. For example, while DOE plans to complete its $6.5-billion expenditure for the gas centrifuge facility by 1994, it does not plan to completely recover that investment through depreciation until 25 years after the facility begins to operate in fiscal year 1986. Therefore, this difference in the expenditure and recovery rate, along with other new expenditures, will cause the government's unrecovered costs in the enrichment program to temporarily increase. The amount of such an increase is largely dependent on the extent to which DOE deploys new and advanced technologies, the cost of those technologies, and the price charged for enrichment services.

It also should be noted, as discussed in our April 25, 1984, report, that DOE has decided not to recover about $1.2 billion of the existing unrecovered costs in the gaseous diffusion enrichment plants. DOE's decision was based on its estimation that only about 40 percent of the capacity of the gaseous diffusion plants will be needed to satisfy its future demand for enrichment services. Because the Uranium Enrichment Services Criteria requires DOE to recover "appropriate depreciation," DOE believes that only about 40 percent of the $2 billion remaining in unrecovered depreciation costs should be included in the price.

Finally, Section 161(v) of the Atomic Energy Act of 1954, as amended, does not include a repayment requirement but instead requires DOE to recover the government's costs of providing enrichment services. However, GAO is currently making a legal determination in accordance with your request of May 3, 1984, as to whether or not DOE's decision not to recover assets totaling about $1.2 billion is in compliance with the cost recovery provision of the act. In addition, we are making a legal determination concerning the legality and propriety of DOE's unilateral establishment of a ceiling price in its new enrichment services contract, and obligations the government will incur as a result of the new contract.

Question: Please identify any repayments to the Treasury by the program of this (unrecovered government costs) borrowed amount.

GAO response

DOE has not made specific repayments to the Treasury, as indicated in the response to the previous question, because no specific repayments are required. Government costs are being recovered, however, and have been designated by the Congress for use as part of actual appropriations or to offset appropriations. A discussion of this is also found in the previous response.

Question: The program has been charging its customers for depreciation of the original government investment. What use was made of these customer funds if the funds were not used to repay the government's loan to the program?

GAO response

As indicated in your question, the enrichment program charges its customers for depreciation of the government's unrecovered cost in plant and equipment. The fiscal year 1971 financial statements showed that the government's unrecovered cost was about $1.4 billion, and of that amount, about $1 billion was the remaining undepreciated balance of the original gaseous diffusion plants. The fiscal year 1983 financial statements showed that the undepreciated balance in the gaseous diffusion plants had grown to about $2 billion because of the Cascade Improvement and Uprating Programs and other plant improvements. However, of this $2 billion, only about $300 million represents the undepreciated balance of the original gaseous diffusion plants. Thus, about $700 million ($1 billion minus $300 million) of the original gaseous diffusion plants has been recovered through the depreciation portion of the enrichment services price that DOE has charged its enrichment customers. These recovered costs, along with all other recovered costs, have been added to or used to offset annual program appropriations for operating and capital expenditures or, in some cases, transferred to other DOE programs in accordance with the various appropriation acts.

QUESTIONS ABOUT THE AUDITS OF THE URANIUM ENRICHMENT PROGRAM'S FINANCIAL STATEMENTS

Question: What internal DOE auditing is performed to ensure the accuracy of the Uranium Enrichment Program's annual financial statements?

GAO response

Annual financial statements have been prepared for the Uranium Enrichment Program since fiscal year 1971.[12] The program's statements serve as a supplement to DOE's annual agencywide financial report. Although there are no legislative or regulatory requirements that the Uranium Enrichment Program's financial statements be audited, annual audits have been performed since fiscal year 1972.

Over the years, financial statement audits have been performed by three different DOE (and predecessor agencies) audit groups. The following chart identifies those groups and indicates the statements they audited.

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[12]The Uranium Enrichment Program is not a separate or distinct enterprise within or apart from DOE. However, DOE and its predecessor agencies decided it was necessary for the program to have its own financial statements (1) to provide public information on the program's financial position and results of operations and (2) to provide DOE management with financial data to assist them in ensuring that the program is meeting its statutory requirement of recovering the government's costs of providing enrichment services.

DOE Groups That Audited the Uranium Enrichment Program's Financial Statements for Fiscal Years 1972-83

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Finance Division's Audit Branch[a]	X	X	X	X	—	—	—	—	—	—	—	—
Office of Performance Evaluation[a]	—	—	—	—	X	X[b]	X	X	X	—	X	X
Office of the Inspector General[c]	—	—	—	—	—	—	—	—	—	X	X	—

[a]The Finance Division's Audit Branch became part of the Office of Performance Evaluation which is located at DOE's Oak Ridge Operations Office, Oak Ridge, Tennessee.

[b]The printed fiscal year 1977 financial statements for the enrichment program indicate that the audit of the statements was conducted by the Office of the Inspector General. According to DOE, that printed statement is in error; the audit was actually conducted by the Office of Performance Evaluation.

[c]The Office of the Inspector General performed the fiscal year 1982 audit with the assistance of personnel from the Office of Performance Evaluation.

Source: Prepared by GAO using information obtained from DOE's Finance Division, Oak Ridge Operations Office.

Our review of the published financial statements revealed that only the fiscal year 1982 statements contained language stating that they had been examined in accordance with generally accepted government auditing standards.[13] An audit conducted under generally accepted government auditing standards would require at least a preliminary study and evaluation of internal accounting controls, an evaluation of compliance with laws and regulations, and substantiation of account balances through vouching, confirmation, and other audit procedures. Material

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[13]Generally accepted government auditing standards relate to the scope and quality of audit effort and to the characteristics of professional and meaningful audit reports. These standards must be used for audits of government organizations, programs, activities, and functions whether performed by government or nongovernment auditors and are published by GAO in its Standards for Audit of Governmental Organizations, Programs, Activities, and Functions, revised Feb. 27, 1981.

departures from generally accepted accounting principles[14] would require an explanation in the footnotes to the financial statements and disclosure in the auditor's opinion.

The Inspector General's office was originally scheduled to audit the financial statements for fiscal year 1983 but told us that because it lacked sufficient staff, the Office of Performance Evaluation conducted the audit. Officials from the Office of Performance Evaluation told us that their examination consisted primarily of reviews conducted in accordance with established criteria, assumptions, and instructions of DOE's management, and only as applicable, generally accepted accounting principles. For fiscal year 1984, officials from the Office of Performance Evaluation and the Office of the Inspector General have indicated that neither office has plans to audit the financial statements. Therefore, according to DOE, no audit group has been designated to conduct the audit of the fiscal year 1984 financial statements.

On July 6, 1984, we spoke with the Deputy Assistant Secretary for Uranium Enrichment concerning future audits of the program's financial statements. He said that the auditing of the statements will be extremely important in the future since one of DOE's long-range plans is to encourage private investment for new plant and equipment. As such, he said he is planning to recommend to DOE management that the annual audits be conducted by a certified public accounting firm. As of that date, however, no official recommendation had been made.

Question: What certification, either internal or external to DOE, should be provided to enhance the stature and the quality of the financial statement?

GAO response

To enhance the stature and the quality of the Uranium Enrichment Program's financial statements, they should be examined annually by independent auditors in accordance with generally accepted government auditing standards. An auditor's opinion should be expressed on (1) the fairness of the statement's presentation of the program's financial position and results of operations for the period then ended and (2) the consistency of the

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[14] "Generally accepted accounting principles" (GAAP) refers to the conventions, rules, and procedures necessary to define accepted accounting practice at a particular time. These principles are provided by various publications of the American Institute of Certified Public Accountants and the Financial Accounting Standards Board. Federal agencies are required to follow Title II of the Policy and Procedures Manual for Guidance of Federal Agencies, issued by GAO, which constitutes federal generally accepted accounting principles.

statements with generally accepted accounting principles. In all matters relating to the audit work, generally accepted government auditing standards require that the audit organization and the individual auditors, whether government or private, be free from personal or external impairments to independence, be organizationally independent, and maintain an independent attitude and appearance.

In accordance with generally accepted government auditing standards, the only DOE audit group considered to have organizational independence to conduct an audit of this program's financial statements is the Office of the Inspector General. As shown in the chart on page 12, since DOE's Office of the Inspector General was established in 1977, it has only conducted two of the program's financial statement audits. The Office of Performance Evaluation assisted in one of these, the fiscal year 1982 audit. Thus, the remaining audits, including the most recent one, were conducted by audit groups that are not considered to have the proper organizational independence.

Question: Does the General Accounting Office audit each financial statement published by the Department?

GAO response

When the first financial statements for this program were being prepared for issuance in 1971, GAO reviewed the accounting principles, theories, and methods used in the development of those statements and made several suggestions,[15] some of which were implemented by the Controller of the former Atomic Energy Commission. We also suggested that the financial statements be published annually. While GAO has not performed a financial audit of any of the Uranium Enrichment Program's financial statements, we plan to audit the fiscal year 1984 statements. Our authority to conduct such an audit is provided by the Accounting and Auditing Act of 1950.[16]

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[15]Price Increase and Change in Criteria for Uranium Enrichment Services (B-159687, Feb. 9, 1971) and report to the Chairman of the Atomic Energy Commission (B-159687, Mar. 31, 1972).

[16]The Accounting and Auditing Act of 1950 (CH. 946, Title I, Part II; 64 STAT. 834) provides GAO with general statutory authority for auditing executive branch departments.

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Question: What is generally acceptable accounting procedure for certification of a private corporation's financial statement?

GAO response

Most corporations whose stock is publicly traded are required by the Securities and Exchange Commission to have an annual audit performed by an independent public accountant. A company's articles of incorporation, stockholders, and lenders may also require periodic independent audits. Sound management practice also argues for annual examination of a company's financial statements by independent auditors, even if such an audit is not specifically required.

An audit of financial statements in the private sector is conducted in accordance with the published generally accepted auditing standards prescribed by the American Institute of Certified Public Accountants. A company's board of directors or audit committee typically selects a certified public accounting firm to conduct an annual audit in accordance with generally accepted auditing standards. The purpose of such an audit is to obtain an opinion on the fairness and consistency of the presentation of the company's financial statements in accordance with generally accepted accounting principles. The financial statements, which include the audit firm's opinion, are issued to stockholders, creditors, potential investors, and other interested parties separately, or incorporated in the corporation's annual report.

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Unless you publicly announce its contents earlier, we plan no further distribution of this report until 7 days from its publication date. At that time, we will send copies to the Director, Office of Management and Budget; the Secretary of Energy; and interested committees and Members of Congress. Copies will also be made available to others upon request.

J. Dexter Peach
Director

Enclosure

ENCLOSURE I

ENCLOSURE I

Uranium Enrichment Program
Revenues For Fiscal Years
1972 Through 1983

Fiscal year	Amount (in millions)
1972	$ 165.2
1973	266.1
1974	460.2
1975	323.6
1976	612.0
1977	717.9
1978	1,045.8
1979	1,414.2
1980	1,304.1
1981	1,335.7
1982	2,062.8
1983	2,169.4
Total	$11,877.0

SOURCE: Prepared by GAO using data from the enrichment program's fiscal year 1972-83 financial statements.

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

RESOURCES, COMMUNITY, AND ECONOMIC DEVELOPMENT DIVISION

FEB 27 1986

Comments on Proposed Uranium Enrichment Criteria
NE-34
Room A-172, Germantown
U.S. Department of Energy
Germantown, MD 20545

In accordance with the Department of Energy's (DOE) notice of proposed rulemaking (10 CFR Part 762) published in the Federal Register on January 29, 1986, the General Accounting Office (GAO) requests that this letter and the enclosed documents be made part of the rulemaking record. The documents consist of:

--GAO's February 19, 1986, legal opinion on the consistency of DOE's proposed criteria with the Atomic Energy Act requirements for the enrichment program;

--GAO's February 19, 1986, testimony before the Subcommittee on Energy Conservation and Power, House Committee on Energy and Commerce, concerning the proposed criteria's appropriateness, legality, and impact on future congressional oversight; and

--GAO's December 27, 1984, legal opinion which provides a detailed analysis of the legislative history of the statutory provisions governing the program and of the 1973 amendments to the criteria.

In summary, GAO believes DOE's proposed criteria revision does serve a useful purpose in that it places in the public record DOE's objectives for the program, the flexibility it believes is needed to allow it to compete in the world marketplace, and a clear position on the amount of unrecovered government costs that it plans to recover from future program revenues. To the extent that these modifications represent the administration's view on the appropriate enrichment program objectives and structure for today's enrichment environment, they are a first step in facilitating the program reevaluation we have consistently called for over the last few years.

We do, however, have concerns about the criteria. We believe that program changes involving such a major redirection of the uranium enrichment program should be accomplished by legislative changes with criteria subsequently developed that flow logically from and are consistent with the legislation. Our December 27, 1984, legal opinion explains the statutory requirements that

govern the enrichment program, and our February 19, 1986, testimony addresses DOE proposed redirection of the program. Our February 19, 1986, legal opinion discusses in more detail the areas where we believe the proposed criteria conflict with existing legislation.

In addition to the legal conflict, the proposed criteria makes congressional oversight difficult. They have been written in a manner that provides DOE maximum flexibility to operate the enrichment program, and have few feedback provisions or accountability measures. Given this flexibility, benchmarks that have been useful in the past to monitor the program, such as a clear definition of what costs should be recovered, how prices will be determined, and the general approach to contract terms, would be removed.

Please contact my office if you desire additional information.

Sincerely yours,

Ralph Fortune for

J. Dexter Peach
Director

Enclosures - 3

Mr. Bevill. Can you recite for me the legal authority under which you propose to make payments to Treasury?

Mr. Vaughan. Section 161v of the Atomic Energy Act states that the charge for enrichment services shall recover the Government's costs of providing enrichment services over a reasonable period of time. The Administration's proposal would have the Department of Energy establish payments equivalent to the outstanding unrecovered costs associated with providing enrichment services. The basis for this approach is Section 161v of the Atomic Energy Act.

Mr. Bevill. Is the $3.5 billion in unrecovered Government cost in any way associated with this year's debt figures? Aren't all of those costs sunk and weren't they spent decades ago? How much of it is imputed interest?

Mr. Vaughan. The $3.5 billion represents unrecovered Government investment in uranium enrichment which the Department expects to recover through future sales. The $3.5 billion consists of the undepreciated gaseous diffusion plants, uranium and separative work inventories, working capital and cumulative loss from operations. All interest costs have been included in the cumulative results of operations.

INVENTORY

Mr. Bevill. To make payments to Treasury in FY 1986 and FY 1987 you say that you are planning to sell SWUs out of your inventory. Yet you indicated that your marginal production cost is very low, around $35 per SWU. What is the value of the inventory you are selling and aren't you really losing money by doing this. Thus, isn't it rather short sighted?

Mr. Vaughan. You are correct in your assertion that the FY 1987 production level was largely determined based on budgetary considerations. We believe that the scheduled production level for FY 1987 is reasonable given the TVA demand charge of $450 million, the payment to Treasury of $235 million, and the requirement to price competitively.

HISTORY OF COSTS AND REVENUES

Mr. Revill. For each of the past 20 years; provide the revenues, expenses, net appropriations incurred by the uranium enrichment enterprise and identify amounts associated with national security requirements, reprogrammings, etc.

Mr. Vaughan. We have prepared a table that we will provide for the record that identifies uranium enrichment cost and revenues collected from 1969, when commercial sales began, through 1985. We show program costs to enable a clear delineation of what the Government has spent on uranium enrichment. This approach adjusts for reprogramming, unobligated balances and other adjustments. For the purposes of this table, we have excluded costs for interest.

(The information follows:)

URANIUM ENRICHMENT COSTS
(Dollars in Millions)

Fiscal Year	Total Costs	Revenues	Net
1969	135.7	30.0	-105.7
1970	172.9	83.8	-89.1
1971	191.5	220.6	29.1
1972	251.4	181.7	-69.7
1973	328.6	252.5	-76.1
1974	416.8	719.7	302.9
1975	626.3	546.4	-79.9
1976/TQ	1,132.3	832.3	-300.0
1977	1,142.0	635.0	-507.0
1978	1,249.6	965.8	-283.8
1979	1,308.1	1,217.1	-91.0
1980	1,321.0	1,117.0	-204.0
1981	1,485.5	1,248.0	-237.5
1982	1,665.4	1,721.7	56.3
1983	1,617.4	1,697.2	79.8
1984	1,841.4	1,852.0	10.6
1985	1,754.7	1,410.9	-343.8
TOTAL	16,640.6	14,731.7	-1,908.9

Prior to FY 1983, revenues from deliveries to Government users were not separately appropriated to the DOE Office of Defense Programs and were not collected by the Uranium Enrichment program. For the years FY 1969 through FY 1982, these imputed revenues total about $980 million and are not included in the table. Since FY 1983, we have received revenues for deliveries to Covernment users in the amount of $391.7 million and this amount is reflected in the above table. We estimate the FY 1986 Government-related revenue to be $169.6 million and the FY 1987 amount to be $208.5 million.

Mr. Bevill. Do you believe that Congress gave you direction to set your prices for civilian uranium enrichment services on the basis of recovery of appropriate Government costs over a reasonable period of time? Were the prices over the past 16 years set to recover all such costs?

Mr. Vaughan. Section 161v of the Atomic Energy Act gave us such direction. The existing and all past prices have been set to recover the Government's costs over a reasonable period of time.

Mr. Bevill. Did Congress give you the authority to permit costs to be carried forward to future years and to be included in the price for services to future customers? If so, what is the basis for your position? If not, why are you proposing this in the new uranium enrichment criteria?

Mr. Vaughan. The Atomic Energy Act permits some costs to be recovered in future years, since the law provides for recovery of appropriate costs over a reasonable period of time. This is the basis of prior pricing practices as well as for the new criteria proposal.

COST OF ENRICHMENT FOR MILITARY PURPOSES

Mr. Bevill. Have the costs of uranium enrichment activities been properly segregated into the categories of military, non-proliferation/ national security and civilian production over the past 16 years of operation? Can they be so segregated on an actual or an estimated basis?

Mr. Vaughan. Separate cost accounting systems were not established for military and civilian production in the past. For low assay production there is no distinction of costs depending on the ultimate users. The vast majority of all enrichment services for military needs come from low assay enrichment. For high assay enrichment it is possible to establish a separate cost accounting system for this production. The Department of Energy, DOE, has recently completed this action and in the future all high assay production will be sold, whether to military or civilian purchasers, at costs equal to their actual cost of production. The FY 1987 budget for Defense Programs revenues reflects this distinction. High assay production costs prior to FY 1986 can be estimated, based on best available information. Exact costs cannot be determined since there was no separate cost accounting system in place.

Mr. Bevill. Does it cost more for each "separative work unit" to produce the high enriched uranium for military use compared to the cost for the low enriched civilian product? If so, what is the difference?

Mr. Vaughan. Yes, it costs more for high assay enrichment than it does for low assay enrichment. High assay enrichment costs more per SWU because of increased costs associated with higher energy requirements and higher overhead costs, particularly for safeguard and security requirements, and because of the low volume of high assay enrichment. This cost differential between high and low enrichment is not dependent on whether the product is needed by civilian or military users.

Mr. Bevill. Is it fair to ask customers for civilian products to pay for the facilities bought for military purposes or for those elements of the program that are performed for national security reasons?

Mr. Vaughan. Our pricing and accounting structures are now designed to ensure that the charges to commercial customers do not include any costs relating to providing enriched uranium to military and other Government customers. The gaseous diffusion plants were built to meet the requirements of the military. In the 1960's when military requirements were significantly reduced, and commercial requirements began to increase, the original gaseous diffusion plants were only about 50 percent depreciated. The correct and fair allocation of the undepreciated costs is to assign future depreciation costs to future production for both commercial and military customers. To ensure that a fair allocation of future depreciation costs was made, the original criteria contained a provision, called the Conway formula, that allocated future depreciation amounts between the users of enrichment services and the Government based on the percent of plant capacity in use.

GDP OPERATIONS

Mr. Bevill. What is the status of the Oak Ridge diffusion plant?

Mr. Vaughan. Planning for placing the Oak Ridge Gaseous Diffusion Plant, ORGDP, in standby began immediately following the Secretary's June 5, 1985, decision. Standby operation was initiated on August 1, 1985, and by August 2, essentially all of the uranium hexafluoride process gas had been removed from the process equipment. The equipment was then purged with dry air to remove residual uranium hexafluoride. The power to the cascades was reduced to zero on August 27, 1985. The process equipment has been back-filled with dry nitrogen to protect the diffusion barrier. The chromated recirculating water that was used in the cooling systems has been disposed of. The wet-type fire protection sprinkler system is being modified to a dry-type system which will not be susceptible to freezing. This modification, scheduled to be finished this fall, will complete the activities to place ORGDP in standby.

Mr. Bevill. What will happen to it in FY 1987?

Mr. Vaughan. In FY 1987, activities related to maintaining ORGDP in a standby condition will continue, with funding provided by Defense Programs. If the standby funding is not provided, ORGDP will be permanently shut down. If the plant is permanently shut down, it will not be operable.

GDP OPERATIONS

Mr. Bevill. If you plan to make further cuts in the program to accommodate revenue shortfalls, there must be a point beyond which you have to close one of the two remaining GDP's. Is this true? What is the funding level at which this occurs?

Mr. Vaughan. The minimum power level below which the Portsmouth and Paducah Plants can no longer operate is about 550 MWe per plant. If revenue shortfalls of about $120 million below projections were to occur, we would reduce power purchases to the point that this minimum power level could not be sustained at both plants, in which case we would proceed to put the Paducah plant into standby. However, due to our existing stockpile of preproduced enriched uranium, we could put the Paducah plant in standby and still meet customer deliveries in FY 1987.

DOMESTIC URANIUM INDUSTRY

Mr. Bevill. If the uranium supply industry is successful in its legal challenge against the DOE, will the outcome help them to achieve viability in the internationally competitive market for uranium or enrichment services?

Mr. Vaughan. We do not believe a favorable ruling for the plaintiffs will help the uranium mining industry become viable. As the U.S. Trade Representative determined, the problems facing the uranium mining industry are due to the failure of anticipated demand to materialize and the large inventories in the hands of customers that further depress near-term requirements. These same problems were facing the Department of Energy (DOE) uranium enrichment enterprise. Through bold management steps, DOE pared its enrichment capacity to match demand more closely by placing the Oak Ridge Gaseous Diffusion Plant in standby and terminating all work on the Gas Centrifuge Enrichment Plant and the advanced gas centrifuge development program.

A favorable ruling for the plaintiffs could significantly damage the DOE enrichment business. Since the law suit against DOE is a five count complaint, let me briefly comment on each count.

Count 1 alleges that DOE has failed to fulfill a statutory duty to protect the domestic mining industry from imports of foreign uranium by restricting the enrichment of foreign uranium for domestic end use.

However, such import restrictions would not assure the viability of the domestic mining industry. Indeed, a sweeping limitation would likely cause many of DOE's customers to cancel their contracts with us and obtain their enrichment services overseas. Not only would DOE's sales be decreased, but the domestic mining industry would most likely lose any chance of future sales as domestic customers would become more firmly tied to overseas suppliers who offer package deals for both natural uranium and enrichment.

Count 2 is the only complaint that has been considered by the District Court for the District of Colorado. The District Court found that the generic Utility Services contract was null and void because the contract amounted to a change in the Enrichment Services Criteria and, further, such contract was not submitted to Congress. DOE filed its Notice of Appeal with the U.S. Court of Appeals for the 10th Circuit on September 25, 1985. In addition, on January 29, 1986, DOE issued a Notice of Proposed Rulemaking in the Federal Register. The proposed rulemaking will eliminate the conflicts that District Court perceived between the Enrichment Services Criteria and the Utility Services contract. When the pending rulemaking is complete, the appeal before the U.S. Court of Appeals will become moot.

Count 3 is a puzzlement. It alleges that DOE has a "fixed tails policy." This is not true. Since July 1978, when DOE issued the Adjustable Fixed Commitment contract, enrichment customers have been permitted to select their own tails assay under the Variable Tails Assay Option or VTAO. The Utility Services contract also contains a VTAO provision. Moreover, on September 26, 1985, in order to stimulate sales of

domestic uranium, the Secretary offered a free VTAO to utilities who purchase all of their requirements under the Utility Services contract.

Count 4 alleges that DOE's "split tails" and "preproduced inventory" policies amount to sales by DOE of natural and enriched uranium from its stockpile in competition with, and to the detriment of, the domestic mining industry. This is false. Our enrichment customers buy natural uranium from the mining industry, and deliver uranium feed to us, based on a transaction tails assay that they are free to choose under VTAO. DOE's use of its inventories of natural and enriched uranium in no way affects the enrichment customers' relationship with the mining industry. DOE has used the split tails mode of operation to reduce operating expenditures by using the natural uranium previously purchased by the Government to stimulate the domestic mining industry. Although there is no effect on the mining industry whether split tails is used or not, the Secretary has postponed the use of Government-owned feed to avoid even the perception of harm to the industry. Our preproduced inventory of enriched uranium is being used to meet our customers' requirements while electric power purchases are decreased to reduce budget expenditures. A finding favorable to the mining industry on Count 4 would severely hamper our enrichment operations by tieing up our inventories of natural and enriched uranium. We would be faced with either not meeting our contractual requirements and/or requiring budget authority to purchase electric power not covered by our enrichment revenues. The mining industry would not benefit in any way from a finding in their favor on this count.

Finally, Count 5 alleges that the regulations adopted by DOE for determining the viability of the domestic mining industry are invalid. We believe all pertinent regulations were followed. However, since the Secretary determined on September 25, 1985, that the U.S. mining industry was not viable in 1984, we do not understand how a finding favorable to the mining industry on Count 5 would assist the industry.

Mr. Bevill. Will some restriction on the enrichment of foreign source uranium help the domestic uranium supply industry or will it simply drive your enrichment customers to overseas suppliers?

Mr. Vaughan. Import restrictions would have undesirable effects on both the U.S. uranium industry and the DOE enrichment business. A sweeping limitation would likely cause many of DOE's customers to terminate their enrichment contracts with DOE since lower cost uranium and enrichment services can be purchased from foreign sources. Many of these customers currently may be paying a premium for the reliability they expect from dealing with the U.S. enrichment enterprise. The uncertainty about the future costs of nuclear fuel engendered by an import embargo would diminish their willingness to pay such a premium and thus increase the likelihood they might seek enrichment services from abroad. Information available to DOE suggests that for a uranium price difference of as little as ten dollars per pound, a U.S. utility could cancel its DOE enrichment contract immediately, pay the termination fee, buy enrichment services overseas, and save money. Lost sales resulting from such terminations could reach $300 million annually by 1988.

REVENUE SHORTFALL IMPACT

Mr. Bevill. Mr. Longenecker, you have established target payments to Treasury of $110 million in 1986 and $235 million in 1987. These payments must be based on certain assumptions for commercial and military sales. With all the uncertainties surrounding the business right now, including the rulemaking and the miners' lawsuit, what will you do if your revenues don't materialize as you have projected? Will you reduce the payment to Treasury or will you further cut into your program?

Mr. Longenecker. The proposed FY 1987 budget assumes that payments to Treasury take first priority in our budget. Thus, if shortfalls occur in either civilian or military revenues, we would plan to reduce program expenses to maintain the capability to make payments to Treasury of $110 million in FY 1986 and $235 million in FY 1987.

SALE OF INVENTORY

Mr. Bevill. What is the long-term impact of selling off the inventory at the pace proposed in the FY 1987 budget? What is the optimum sale rate?

Mr. Vaughan. Our economic analyses generally indicate that the surplus enriched uranium inventory must be reduced over the next several years to enable payment of the Tennessee Valley Authority (TVA) demand charges and payments to Treasury. The optimal sales rate, of course, is highly dependent upon assumptions regarding present and future enrichment services demand as well as cost assumptions. The drawdown of inventory planned for FY 1987 is certainly within the envelope of reasonable drawdown schedules over the range of assumptions analyzed. We do not believe that the rapid drawdown of inventory proposed for FY 1987 will have any significant long-term impact on the economics of the uranium enrichment program.

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Mr. Bevill. Is this a prudent business decision?

Mr. Vaughan. We certainly believe that it is a realistic response to the demands facing the enterprise. As I said earlier, the rapid drawdown is reasonable since it provides us the ability to meet our price targets as well as to permit the scheduled payments to Treasury.

Mr. Bevill. What is the value of the inventory? What will it be at the end of each of the next five years?

Mr. Vaughan. At the end of FY 1985, the value of the Separative Work Unit, SWU, stockpile was $1.663 billion. The value of the SWU inventory at the end of each of the next 5 years is shown in a table which I would like to insert in the record.

(The information follows:)

Value of SWU Stockpile

Fiscal Year	$ Billions
1986	1.436
1987	1.218
1988	.794
1989	.617
1990	.654

AVLIS "PRIVATIZATION"

Mr. Bevill. What is the driving force that leads the Department to propose privatizing AVLIS just about 6 months after the Secretary announced its selection over AGC?

Mr. Vaughan. A principal driving force for privatizing Atomic Vapor Laser Isotope Separation, AVLIS, is deficit reduction. In addition, it is compatible with a long term plan to increase private sector involvement and investment in new capacity.

Mr. Bevill. Won't privatization of AVLIS delay its deployment and thus make the United States less competitive?

Mr. Vaughan. Evaluating privatization now may delay deployment slightly, but the delay associated with the FY 1987 budget is probably not crucial to our ability to deploy AVLIS in a timeframe to assure that the enterprise remains competitive.

Mr. Bevill. Did you contemplate privatizing AVLIS when you selected it last June or is this recent initiative a direct result of the 1987 OMB budget passback?

Mr. Vaughan. We did not specifically address AVLIS privatization in June 1985, but the Process Evaluation Board report did clearly point out that the AVLIS technology had a significant potential for obtaining financial participation from the private sector. Privatization of AVLIS is one of the Administration's initiatives for FY 1987.

Mr. Bevill. Why should enrichment customers continue to rely on the United States if you are not committed to deploying AVLIS so that you can have competitive prices in the future?

Mr. Vaughan. The Department remains committed to managing the Uranium Enrichment program in a manner that assures competitive prices in the future. We believe it prudent to evaluate alternative means by which AVLIS may be deployed, and we do not consider that doing so implies any change in our long term competitive goal.

Mr. Bevill. What will be the impact of the Administration's proposal to privatize AVLIS on the AVLIS development program?

Mr. Vaughan. There will be some delay in the program due to the reduced FY 1987 funding. However, we believe that the program will still remain viable and that we will have the capability to deploy AVLIS in the late 1990's when needed to keep the U.S. enrichment enterprise competitive.

Mr. Bevill. Have you been contacted by any organizations that are interested in investing in the deployment of AVLIS?

Mr. Vaughan. We have received no formal offers to invest in the deployment of AVLIS to date. We plan to issue appropriate requests to determine private sector interest in the Uranium Enrichment Enterprise.

Mr. Bevill. How much money would a private company have to invest in AVLIS technology to finish the development and build a plant?

Mr. Vaughan. A private company would have to invest approximately $2.5 billion to finish AVLIS development and build a 10 million separative work unit, SWU, production plant.

Mr. Bevill. If this privatization scheme were followed, when would an AVLIS production plant be operating?

Mr. Vaughan. If privatization, as currently contemplated, is successful, the first AVLIS production plant could be operating in the late 1990's.

Mr. Bevill. How long would a company have to wait for a return on its investment?

Mr. Vaughan. This would depend upon the specifics of how a company constructed its investment and upon the cost of production. Our preliminary assessment is that a company could expect positive annual cash flow from a $2.5 billion investment in AVLIS demonstration and deployment about 15 years after making the initial investment.

Mr. Bevill. What would the rate of return be?

Mr. Vaughan. The rate of return is heavily dependent on investment assumptions. Based on our preliminary analyses, however, the Government projection is that over 25 years, the rate of return could be in the range of 10 to 20 percent.

Mr. Bevill. Could the Administration's privatization proposal result in the loss of the technological lead that we now have on the rest of the world?

Mr. Vaughan. At this time, we are assuming that sufficient financial support can be secured from the private sector to maintain the viability of the AVLIS program through demonstration and deployment. If this were the case, then any technological advantage we presently hold would be preserved. Concerns over losing this technology lead would arise if we are forced to significantly delay AVLIS development and demonstration activities.

Mr. Bevill. Have there been any new issues or technical problems that have arisen in the AVLIS technology since June 1985 that would lead you to conclude that its economics are not as attractive as was portrayed by the Process Evaluation Board?

Mr. Vaughan. No, there have been no new technical or programmatic issues that have arisen since June 1985 that would lead us to doubt our conclusions.

Mr. Bevill. Does the Administration's privatization proposal contemplate recovering any or all of the development cost of AVLIS?

Mr. Vaughan. Currently, AVLIS research and developments costs are being recovered through our SWU price as they are incurred. If the Department is successful in transferring the AVLIS process to a private enricher, some type of payment may be required of the private enricher to compensate the Government for the use of the AVLIS technology.

Mr. Bevill. If the Administration does not propose to recover the AVLIS development costs, why should other prior costs be recovered?

Mr. Vaughan. The Administration is now recovering all AVLIS costs and plans to continue to recover future AVLIS costs.

Mr. Bevill. What would be the SWU cost of material enriched in a "privatized" AVLIS plant?

Mr. Vaughan. We would project that the production cost for a privatized AVLIS plant would be in the range of $35 to $50 per SWU, assuring an annual production rate of approximately 12 million SWU. This is the current target for the AVLIS development program.

Mr. Bevill. Would a private AVLIS plant have to be licensed by the NRC?

Mr. Vaughan. Yes, we assume that a privately owned AVLIS plant would have to be licensed by the Nuclear Regulatory Commission.

GASEOUS DIFFUSION PLANTS

Mr. Bevill. What is the actual cost of producing a single SWU from the GDPs in FY 1986 and FY 1987?

Mr. Vaughan. The average SWU production costs to produce 7.6 million SWU per year in FY 1986 and FY 1987 are $75 per SWU and $69 per SWU, respectively. These costs include all expenses required for the operation and support of the gaseous diffusion plant complex and for the power utilized to operate the diffusion plants. They do not include capacity costs for power not taken and costs to maintain the Oak Ridge Gaseous Diffusion Plant in standby condition.

Mr. Bevill. For each of the next ten years, what is the estimated cost to produce a single SWU?

Mr. Vaughan. The average SWU production costs for the period FY 1988 through FY 1997 are approximately $71 per SWU.

Mr. Bevill. What is the basis for these estimates?

Mr. Vaughan. These costs include all expenses required for the operation and support of the gaseous diffusion plant complex and for the power utilized to operate the diffusion plants. They do not include capacity costs for power not taken and costs to maintain the Oak Ridge Gaseous Diffusion Plant in standby condition.

GCEP INVESTMENT

Mr. Bevill. How much was invested in GCEP and development of centrifuge technology?

Mr. Vaughan. The Department investment in the Gas Centrifuge Enrichment Plant, GCEP, as of September 30, 1985, was $2.589 billion, plus an investment of $998 million in centrifuge technology. We estimate that an additional $150 million for GCEP and $40 million for centrifuge technology will be required to complete termination activities.

Mr. Bevill. What does the Department of Energy intend to do with GCEP facilities.

Mr. Vaughan. At present, the GCEP facilities are being maintained in an operable condition while alternate uses of the centrifuge cascades are explored. If by June of 1986, no alternate use for the centrifuge cascades are found, the GCEP facility will be available for other uses, with the first priority the Department of Energy, the second priority other Federal, State, or local government agencies, and the third priority being the private sector.

Mr. Bevill. Will ratepayers or taxpayers be required to pay for the investment made in GCEP and centrifuge development?

Mr. Vaughan. The Department plans to exclude the Government's investment in GCEP in determining the total amount of Government investment to be recovered through enrichment sales. There is no outstanding investment in centrifuge development as these costs have been expensed and recovered as incurred.

AVLIS INVESTMENT

Mr. Bevill. How much has the United States invested in laser isotope separation technology to date?

Mr. Vaughan. Through fiscal year 1985, about $414.4 million, in outlays, has been invested in the Atomic Vapor Laser Isotope Separation program. We are currently estimating the FY 1986 outlays to be about $85 million.

Mr. Bevill. Will the Department of Energy try to recover this investment in AVLIS if the technology is privatized?

Mr. Vaughan. As with centrifuge research and development costs, Atomic Vapor Laser Isotope Separation, AVLIS, research and development costs have been primarily expensed and recovered as incurred. If the AVLIS technology is transferred to a private enricher, some type of reimbursement may be assessed for use of the AVLIS technology. We have not yet determined the mechanism for this charge.

Mr. Bevill. Will ratepayers be required to repay this investment if the program is privatized? If not, how are these costs to be carried and by whom?

Mr. Vaughan. The ratepayers have already paid for these costs. If funds are received from a private enricher for use of AVLIS technology, the ratepayer will receive a credit through lower future prices to avoid recovery of costs a second time.

MARKET SHARE

Mr. Bevill. What is the current U.S. share of the domestic and world enriched uranium market?

Mr. Vaughan. In 1986, the Department of Energy, DOE, will supply about 46 percent of the total free world enriched uranium market. Considering only the U.S. market, DOE will supply about 85 percent of domestic reactor fuel requirements in 1986.

Mr. Bevill. How does this compare with 5 years ago? 10 years ago? Provide a table showing the U.S. share for each of the last 10 years.

Mr. Vaughan. The U.S. share of the domestic and free world enriched uranium market for each of the last 10 years is shown in a table I would like to insert in the record.

(The information follows:)

U.S. Share of Enrichment Demand

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Percent of Free World Market	99	89	80	74	55	54	57	68	55	47
Percent of Domestic Market	100	100	100	100	100	100	100	95	87	76

Mr. Bevill. What is the Department doing to regain market share?

Mr. Vaughan. The Department is attempting to regain its market share by retaining competitive prices, flexible terms, and reliable service. This includes offering our enrichment customers attractive prices and, in turn, taking steps to operate each element of the enterprise in a cost effective manner and allowing the market to drive decisions on investments for new capacity and for research and development.

In the last year we have taken advantage of opportunities to hold our competitive position and through several innovative marketing initiatives to increase market share. These initiatives include offering Incentive Price proposals for our customer's uncommitted requirements from FY 1987 through FY 1995. These marketing initiatives were very successful in that 87 percent of opportunities between 1987 and 1990 were captured by DOE and 75 percent in 1991 through 1995. In addition, we have reduced our base price to $119 per SWU in FY 1987 which is the third consecutive year DOE has been able to reduce our customer's cost. The primary target of opportunity in the near term continues to be the uncommitted civilian demand of our customers.

Mr. Bevill. What is the Department doing to retain market share over the next ten years?

Mr. Vaughan. Our customers, both domestic and foreign, will purchase their enrichment requirements from the supplier that offers them the best price, terms and service.

In order for the United States to capture and maintain a significant share of the enrichment market, we plan to be competitive in price, terms, and conditions. We are committed to being a reliable supplier, to knowing our customers' needs, anticipating future concerns, and to being responsive to them. To achieve this, we plan to operate more efficiently, reduce our costs, introduce advanced technology when appropriate to keep prices competitive, and to base all our production and business decisions on current and realistic projections of future markets. We must also know our competitions' strengths and weaknesses and be prepared to act creatively and aggressively to maintain or enhance our market share.

We have made significant progress in these areas over the past 3 years and will continue to do so by operating in a sound, businesslike manner.

BORROWING AUTHORITY

Mr. Bevill. Would the availability of borrowing authority put the uranium enrichment enterprise on a more businesslike basis? How?

Mr. Vaughan. To date, the Administration has not established a policy on borrowing authority for the Uranium Enrichment program.

Mr. Bevill. Discuss the advantages of borrowing authority.

Mr. Vaughan. To date, the Administration has not established a policy on borrowing authority for the Uranium Enrichment program.

Mr. Bevill. How would repayment of such borrowed funds be made?

Mr. Vaughan. The Department of Energy would make payments, including interest, from customer revenues, over a fixed period of time.

Mr. Bevill. What is the Administration's policy in regard to borrowing authority?

Mr. Vaughan. To date, the Administration has not established a policy on borrowing authority for the uranium enrichment enterprise.

SECONDARY MARKET

Mr. Bevill. What is the current situation in the secondary market for enriched uranium, what causes it, and what effect does it have on prices and markets?

Mr. Vaughan. Currently in the secondary market there are more sellers than buyers. The secondary market for enriched uranium is a product of the imbalance that existed in the past between supply and demand. All enrichment suppliers, including the United States, held enrichment contracts with fixed purchase commitments which did not coincide with the unexpected decline in energy growth and nuclear plant operational perturbations. Therefore, decreased demand and "take-or-pay" contracts with suppliers resulted in increasing inventories of excess enriched uranium. Utilities, forced to take the unneeded enriched uranium, are attempting to sell excesses at substantial discounts rather than holding unneeded inventories with escalating carrying costs. In response to customer needs, DOE introduced in 1984 the Utility Services enrichment contracts with enhanced flexibilities to work off excess inventories and facilitate a balance between supply and demand for customers holding contracts with DOE.

Mr. Bevill. How much enriched material is available on the secondary market?

Mr. Vaughan. Currently about 1 million SWU's of DOE-origin enriched material exists on the secondary market. Approximately 15 to 17 million SWU's of non-DOE origin enriched material is also available.

Mr. Bevill. What is the average SWU price of this material?

Mr. Vaughan. According to market sources, the average SWU price of DOE-origin excess enriched material is between $75 and $85 per SWU, and the average SWU price of non-DOE excess enriched material is reported to be between $60 and $80 per SWU.

UNOBLIGATED BALANCES

Mr. Bevill. What are the FY 1985, 1986, 1987 estimated unobligated balances in this program and why did they occur?

Mr. Vaughan. For fiscal year ending 1985, the unobligated balance was $221.0 million. This amount is primarily due to a deferral of $200.0 million to FY 1986 for transfer to the Energy Supply, Research and Development appropriation in accordance to P.L. 99-141 and a deferral of $15.0 million for transfer to the Geothermal Resources Development Fund for loan defaults in accordance with P.L. 99-88, 99 stat 322, 30 U.S.C. 1141. For fiscal years ending 1986 and 1987 there are estimated to be unobligated balances of $584.3 million and $.2 million respectively. The FY 1986 unobligated balance is primarily due to a $584.2 million deferral to FY 1987. The FY 1987 unobligated balance is due to Section 515 of the Treasury-Postal Services Appropriation Act for FY 1986 which requires that 10 percent of the amount requested for fiscal and special studies and analyses be placed in reserve and be made unavailable for obligation.

APPROPRIATION LANGUAGE

Mr. Bevill. What difficulties, if any, have resulted from the application of the appropriation language contained in the FY 1986 Act?

Mr. Vaughan. The fiscal year 1986 appropriation language did not require the Uranium Enrichment program to conduct activities at a level consistent with revenues collected. The proposed fiscal year 1987 appropriation language would modify this situation.

Mr. Bevill. If no difficulties have occurred, why does the FY 1987 request have different language?

Mr. Vaughan. The language proposed for fiscal year 1987 provides a more appropriate funding mechanism in the view of the Administration for the uranium supply and enrichment activities appropriation.

Mr. Bevill. What would be the impact of the program if the proposed language became law?

Mr. Vaughan. At the beginning of the fiscal year contract authority would have to be provided to the enrichment program by the Office of Management and Budget to allow the Department to obligate funds until enough revenues were collected to support the monthly obligation requirements.

PRICING POLICIES

Mr. Bevill. Describe your current pricing policy relative to how the price per SWU is determined. Comment on any changes in accounting practices by the Department which could impact selling price.

Mr. Vaughan. The Department's pricing policy for enrichment services is that prices need to be competitive in the market and also recover the Government's costs over a reasonable period of time. We believe that such an approach is the best way of maximizing revenues and thus recovering the Government's costs. The Department has made two significant accounting policy changes that impact the selling price. These are to exclude the Government's investment in centrifuge related plant and equipment costs and $1.2 billion in unrecovered gaseous diffusion costs from the total unrecovered Government investment in uranium enrichment. These actions reduce the unrecovered investment to be recovered in the future from $7.5 billion to $3.5 billion.

REVENUES

Mr. Bevill. What is the Department's current revenue estimate for FY 1986 and 1987?

Mr. Vaughan. The FY 1986 revenue estimate is $1,360,600,000. The FY 1987 revenue estimate is $1,286,400,000.

Mr. Bevill. What is the basis for this estimate?

Mr. Vaughan. Revenues in FY 1986 are primarily based on the sale of 9.3 million separative work units, SWU, to commercial customers at a value of $1,171,000,000. Also included in the estimate is the sale of 1.7 million SWU to Government customers at a value of $170,000,000. There are also advance payments which have a credit value of $37,000,000. The balance of the revenue estimate comes to $57,000,000 which includes miscellaneous revenues, termination charges, and other account adjustments.

The basis for FY 1987 revenues are the same primary areas as for FY 1986. There are 9.4 million SWU for commercial customers at a value of $1,072,000,000. There are 2.1 million SWU for Government customers at a value of $209,000,000. Also included are advance payments at a credit value of $42,000,000. Finally, there are miscellaneous revenues, termination charges and other account adjustments for $47,000,000.

Mr. Bevill. For the fiscal years 1976 through 1986, provide for the record a comparison showing the Department's estimate of what revenues would be compared to what they actually were.

Mr. Vaughan. The budgetary estimate that is made for revenues for a given fiscal year compares to what is actually collected is included in a table I would like to insert in the record. It should be noted that the estimates in the table are made over 2 years in advance of the actual revenue collections.

(The information follows:)

Estimate vs. Actual Enrichment Revenues
($ in 000)

Fiscal Year	Estimate	Actual Revenue Collection
1976 & TQ	660,680	832,334
1977	659,000	635,041
1978	965,800	965,820
1979	1,209,000	1,217,082
1980	1,310,000	1,117,016
1981	1,254,045	1,248,018
1982	1,805,000	1,721,672
1983	1,834,320	1,697,189
1984	2,240,000	1,851,975
1985	1,675,300	1,410,936
1986	1,612,700	1,360,600 (Estimate)

Mr. Bevill. What are the Department's estimated revenues for each of the fiscal years from 1987 through 2000?

Mr. Vaughan. The Department's estimated uranium enrichment revenues from 1987 through 2000 are shown in a table which I would like to insert in the record.

(The information follows:)

ESTIMATED ANNUAL ENRICHMENT SERVICES REVENUES
(Billions of 1987 Dollars)

Fiscal Year	Revenues $ Billions
1987	1.3
1988	1.5
1989	1.7
1990	1.7
1991	1.7
1992	1.7
1993	1.7
1994	1.6
1995	1.5
1996	2.0
1997	1.9
1998	2.0
1999	1.8
2000	1.7

Mr. Bevill. Are these estimates based on firm contractual arrangements? If not, what is the Department's basis for the estimates?

Mr. Vaughan. Revenue estimates from civilian customers are essentially based on firm utilities services contractual commitments although some judgment was exercised on what portion of the 30 percent uncommitted portion of customer needs will be supplied by the Department of Energy in the mid to late 1990's. It must be remembered, however, that actual deliveries (sales) under the Utility Services contract is requirements based and thus revenues are highly dependent upon how well customer nuclear power plants operate. Revenues from Government users are based upon estimated enriched uranium requirements provided to us from our Office of Defense Programs.

PERSONNEL

Mr. Bevill. Provide a table showing all personnel who are involved in the enrichment enterprise.

Mr. Vaughan. The personnel information you requested is included in a table I would like to insert in the record.

(The information follows:)

ENRICHMENT EMPLOYMENT

Contractor		Estimated Employment
Gaseous Diffusion Plants		
Martin Marietta	Oak Ridge, Tennessee	680
Martin Marietta	Paducah, Kentucky	1,120
Goodyear Atomic	Portsmouth, Ohio	1,805
Gas Centrifuge Enrichment Plant (Being Terminated)		
9 Contractors	Various Locations (Primarily Ohio, Tennessee, and California)	400
Technology R&D		
o AVLIS Development		
University of California	Lawrence Livermore (CA)	640
Martin Marietta	Oak Ridge, Tennessee	240
o Centrifuge Development		
Marietta, Boeing & Others	Oak Ridge, Tennessee	210
Garrett	Torrance, California	80
Goodyear	Akron, Ohio	5
Total Contractor		5,180
Federal Employment		315
	TOTAL	5,495

Mr. Bevill. What is the average annual cost for each category of personnel per manyear shown above?

Mr. Vaughan. The average annual cost information is shown in a table I would like to insert in the record.

(The information follows:)

ENRICHMENT'S AVERAGE ANNUAL COST
OF PERSONNEL PER MANYEAR

Contractor		Estimated Average Cost Per Manyear*
Gaseous Diffusion Plants		
Martin Marietta	Oak Ridge, Tennessee	$38,300
Martin Marietta	Paducah, Kentucky	34,500
Goodyear Atomic	Portsmouth, Ohio	36,200
Gas Centrifuge Enrichment Plant (Being Terminated)		
9 Contractors	Various Locations (Primarily Ohio, Tennessee, and California)	41,000
Technology R&D		
o AVLIS Development		
University of California	Lawrence Livermore (CA)	50,300
Martin Marietta	Oak Ridge, Tennessee	38,300
o Centrifuge Development		
Marietta, Boeing & Others	Oak Ridge, Tennessee)	
Garrett	Torrance, California)	37,000
Goodyear	Akron, Ohio)	
Federal Employment		42,800

*Includes wages, salaries, and fringe benefits.

Mr. Bevill. What is the total personnel cost for the enrichment program?

Mr. Vaughan. The total annual personnel cost, including manpower for the gaseous diffusion, centrifuge, and the Atomic Vapor Laser Isotope Separation programs and overall program management, for enrichment programs is about $212 million.

TVA CAPACITY

Mr. Bevill. What is the basis for the FY 1987 estimate?

Mr. Vaughan. We have 4,485 megawatts of electrical capacity under contract with the Tennessee Valley Authority, TVA. In FY 1987, we anticipate using only about 100 megawatts of this capacity for operation of Oak Ridge National Laboratory and Y-12 facility for which the Uranium Enterprise will be reimbursed. We will be paying capacity charges on the unused 4,385 megawatts capacity at the rate of 11.78 mills per kilowatt hour. The capacity charge for this unused power is estimated to be $451 million and is included in the Department's cascade power budget.

Mr. Bevill. Did TVA build specific power plants to meet DOE contract power requirements? If so, which plants were these? How much did they cost originally. How much have they been depreciated? What is their current value? What is the replacement cost?

Mr. Vaughan. To our knowledge, TVA did not build specific powerplants to meet the Department of Energy's, DOE, contract demand. Rather, the Department's requirements were included in TVA's overall load growth studies which guided TVA's decisions on additions of new generating capacity.

Mr. Bevill. How many megawatts of TVA power is dedicated to DOE?

Mr. Vaughan. The Department currently has a contract demand from TVA of 4,485 megawatts. It remains at 4,485 megawatts until December 1989, when contract demand cancellations begin to take effect. DOE's contract demand reduces to zero megawatts on March 7, 1994.

Mr. Bevill. What is the cost of this power per kWh?

Mr. Vaughan. In FY 1986, DOE is paying 36.34 mills per kilowatt-hour, 11.25 mills capacity and 25.09 mills energy. For FY 1987, we estimate the rate to be 36.96 mills per kilowatt-hour, 11.78 mills capacity and 25.18 mills energy.

Mr. Bevill. How does this compare to other TVA commercial/industrial customers?

Mr. Vaughan. Essentially, the only difference between our rate and the rates paid by the other large, directly-served customers is that DOE's rate is reduced 5 percent for the in-lieu of tax payments made by TVA. As a Federal agency, DOE is not required to make these payments.

Mr. Bevill. If the Department of Energy were to buy the capacity that TVA has dedicated to DOE's needs, what would be the cost to DOE?

Mr. Vaughan. If the Department were to purchase its full contract demand of 4,485 megawatts in FY 1987, it would require an additional $967 million in outlays.

Mr. Bevill. What is the basis for this estimate?

Mr. Vaughan. This is based on the estimated energy rates of 25.18 mills per kilowatt hour.

Mr. Bevill. What impact, if any would there be on TVA power customers if DOE were to purchase this power capacity? Why would there be any impact?

Mr. Vaughan. To our knowledge, there would be no impact except the possible beneficial impact that additional revenues might have in lowering TVA residential and commercial rates.

Mr. Myers. What is the total amount of demand charges paid for power that you have not used for each of the past ten years?

Mr. Vaughan. Payment of capacity charges for power not purchased began in Fiscal Year 1981. In 1981, we paid $27 million; in 1982, $111 million; in 1983, $115 million; in 1984, $226 million; and in 1985, $347 million. In FY 1986, we currently estimate the capacity charges for power not purchased to be $432 million. The FY 1987 budget estimate includes $454 million for capacity charges. With the exception of an estimated $3 million for OVEC and EEInc in 1987, the remaining capacity charges have been or will be paid to TVA.

Mr. Myers. When did you become aware that your power requirements would fall short of your minimum purchases under your long-term contracts?

Mr. Vaughan. We became aware of the possibility that we would not be purchasing our full contract demand from TVA early in Calendar Year 1979, as we undertook the preparation of the Fiscal Year 1981 budget.

Mr. Myers. Even if you held out hope that the loss of international contracts for enrichment that started in the seventies could have reversed, and even if you thought that the U.S. was going to come out of its nuclear power construction tail-spin, didn't you -- at some point -- assume the capability of reducing power requirements through advanced enrichment technologies?

Mr. Vaughan. Yes, we did numerous studies which indicated long-term economic benefits of replacing gaseous diffusion capacity with either Advanced Gas Centrifuge or Atomic Vapor Laser Isotope Separation capacity. This was particularly true several years ago when it was believed that power costs would escalate at a rate much greater than inflation for the foreseeable future. The current expectation is that power costs will escalate at the general inflation rate.

Mr. Myers. Did you ever notify TVA and other power suppliers that you saw no reasonable possibility of using the minimum contracted power?

Mr. Vaughan. Yes, we did. We initiated discussions with all three suppliers, TVA, EEInc, and OVEC, in early Calendar Year 1980 regarding our excess capacity. We were able to reach agreements with EEInc and OVEC to make reductions in the respective contract demands. We have not been able to do so with TVA.

Mr. Myers. To your knowledge, did TVA or any of your other power suppliers begin construction on new generating capacity after knowing that you did not need the power you had contracted for?

Mr. Vaughan. To the best of our knowledge, none of the suppliers began construction of new capacity after learning of our excess contract demand problems.

Mr. Myers. What efforts have you made to obtain relief from the demand charges?

Mr. Vaughan. Unsuccessful attempts to obtain relief from TVA capacity charges have been underway since 1980. Items which have been considered include relief from the capacity charges; resale of TVA power by DOE and/or purchase of power from other utilities; utilization by DOE of seasonal and/or unfirm power from TVA; near-term relief in exchange for additional contractual arrangements beyond the terms of the current power contracts; and bartering of goods and services.

To date, no solution to the excess power under contract problem has been found. There are essentially two roadblocks to a solution. First, TVA's stated belief that resale of the excess DOE contract demand is in violation of the TVA Act, and secondly, TVA's position that any reduction in DOE's obligations could increase the obligations of the other TVA customers.

One option, which DOE has utilized, is to exercise its contractual right to cancel, with an 8-year notice, contract demand. Since December 1981, DOE has cancelled its total TVA contract demand of 4,485 megawatts. These cancellations begin in December 1989 and end in March 1994. These cancellations have reduced DOE's contract obligations for capacity charges over the life of the contracts by about $955 million.

Mr. Myers. Have you looked at some of the contract relief that gas pipelines and distribution firms have won in recent years on their take-or-pay requirements?

Mr. Vaughan. We have followed the contract relief efforts in the natural gas industry to see if any of the developments there could be applied to our excess TVA contract demand problems. However, TVA has not been willing to extend such relief.

REPAYMENT OF INVESTMENT

Mrs. Boggs. Please explain the logic behind the Administration's proposal for repayment of the government's investment in uranium enrichment activities. At a time of very tight budgets and reductions in many essential programs, why should the taxpayer foot the bill? Is this a subsidy for the nuclear power industry or is this bookkeeping slight-of-hand?

Mr. Vaughan. Section 161v of the Atomic Energy Act requires that charges for enrichment services recover the Government's costs of providing enrichment services over a reasonable period of time. Included as a cost to be recovered is approximately $3.5 billion in unrecovered Government investments in the enrichment complex. In FY 1987, the Administration is proposing to recover $235 million of this investment and use the revenues received to make a payment to the Treasury. This payment will help to reduce the Federal deficit.

The Department of Energy, DOE, does not believe its pricing actions represent a subsidy. Annual program costs for civilian toll enrichment purposes, including GCEP and upgrades to the GDP's, have been offset almost totally by customer revenues. DOE proposes to return the U.S. Treasury approximately $3.5 billion of unrecovered Government costs or the approximate value of our assets. The reduction of approximately $4.0 billion in the amount to be recovered is the equivalent of acknowledging that a portion of existing plant capacity will not be used in current or future enrichment operations. We believe this action is

consistent with standard business accounting practices and was found to be so by the General Accounting Office audit of our FY 1984 financial statements.

AVLIS PARTICIPATION

Mrs. Boggs. Why should AVLIS technology be "privatized"? Has any industry or investment group expressed substantial interest in purchasing this technology or is this just another bookkeeping ploy to make the deficit seem smaller?

Mr. Vaughan. The Atomic Vapor Laser Isotope Separation, AVLIS, technology should be privatized if the Department of Energy determines during the course of its ongoing evaluation of private sector participation that doing so will result in a more competitive and reliable U.S. supply of enriched uranium. To date, no industry or investment group has expressed interest in purchasing AVLIS technology. Deficit reduction is a benefit of this initiative and adds impetus to it.

Mrs. Boggs. What would privatization do to the current schedule for bringing the technology on line?

Mr. Vaughan. We anticipate some delay in the AVLIS program due to the reduced FY 1987 funding. Assuming that sufficient private sector support will be available in the outyears, this delay should not result in any significant impacts on the ability of the United States to remain competitive in the world enrichment market.

UTILITY SERVICES CONTRACT

Mrs. Boggs. What is the nature of the litigation involving the Department's Utility Services contract? What effect will the District Court decision in Colorado have on your program if it is sustained?

Mr. Vaughan. The nature of the litigation involving the Department's Utility Services contract is basically an allegation that certain procedural requirements necessary for the implementation of enriching services contracts were not followed. Even if the District Court decision in Colorado is sustained, there likely would not be any impact on the Department of Energy's, DOE, enrichment activities since DOE is engaged in publishing revised enrichment services criteria which will correct the alleged procedural deficiencies identified in the lawsuit.

STATEMENT OF JAMES W. VAUGHAN, JR.
ACTING ASSISTANT SECRETARY FOR NUCLEAR ENERGY
U.S. DEPARTMENT OF ENERGY

FY 1987 APPROPRIATIONS HEARINGS

Mr. Chairman and Members of the Subcommittee, I am pleased to have the opportunity to discuss the Department of Energy's FY 1987 budget request for our Uranium Enrichment activities.

The Department's FY 1987 budget request for the Uranium Enrichment program is approximately $1.05 billion in budget authority, which will be fully offset by $1.29 billion in projected revenues. In addition, the Department of Energy (DOE) proposes to return $235 million to the Treasury as a part of the repayment of prior Government investment in the uranium enrichment enterprise.

The funds requested are distributed among the major elements of the program as follows:

	--($ in Millions)--	
Program Element	FY 1986 Estimate	FY 1987 Request
Uranium Enrichment Activities		
Gaseous Diffusion Operations & Support	$1,075.0	$ 992.6
Atomic Vapor Laser Isotope Separation	127.0	50.0
Gas Centrifuge Program Closeout/Activities	344.4	4.0
Program Direction	4.0	4.8
Subtotal	1,550.4	1,051.4
Payback to Treasury	0*	235.0
Total	1,550.4	1,286.4
Uranium Enrichment Revenues	-1,360.6	-1,286.4
Net Appropriation	189.8	0

* Revenues in excess of outlays of approximately $110 million will accrue to the Treasury in FY 1986.

OVERVIEW

The next 2 years will be a key time period for the uranium enrichment enterprise. During this period the program restructuring which began in 1984 will continue. In the last 2 fiscal years, significant progress has been made in redirecting the enterprise to help assure its competitiveness and long-term viability in the international marketplace. Supply and demand have been stabilized by issuing the Utility Services (US) contracts and by very successfully converting existing customers to the new contracts. Having defined the customer demand that must be met through the conversions to the US contracts, the Department then developed appropriate production and R&D strategies to meet that demand and announced those decisions in June 1985.

Through revision of the Uranium Enrichment Services Criteria, the ground rules under which the enterprise will operate in the future will be refined. The Department will initiate payments to the Treasury in recovery of prior unrecovered costs.

A new initiative now under review is an effort to transfer future development and ultimate deployment of the Atomic Vapor Laser Isotope Separation (AVLIS) technology to the private sector. The areas in which the private sector can most beneficially be involved in the enterprise will be evaulated. At a minimum, it is hoped that the private sector will be interested in deploying the AVLIS technology. This advanced method of enriching uranium holds significant technical and economic potential for the United

States and shquld provide the type of challenge which the private sector has demonstrated its capability to meet. In that light, the Department will initiate later this year an industrial access program to allow qualified U.S. firms to become familiar with the AVLIS technology so that there is an assured industrial base to deploy the technology in the future.

We believe the prospects for a bright future for uranium enrichment in the United States continue to improve. It is clear that the changes made the last few years were necessary. The enterprise is becoming much more cost competitive in operating the existing gaseous diffusion plants and is continuing the development of the world's most advanced enrichment technology for the future. However, there is more to be done. In FY 1987, the Department will develop the institutional framework that will assure that the Nation continues to have a reliable supply of enrichment services for the long term. We must continue to pursue vigorously a restructuring of the enterprise and the involvement of the private sector to assure that the optimum benefits of the strategy on which we embarked several years ago are achieved. A brief review of the elements of that strategy follows.

OBJECTIVES

Our primary objective is to retain a competitive, financially healthy uranium enrichment supply capability in the U.S. for the long term consistent with the Atomic Energy Act, other legal requirements, and the interests of the Nation.

The major goals which have been established for the U.S. uranium enrichment enterprise, as articulated in the June 1985 strategy, include:

- o to bring supply and demand of DOE-origin enriched uranium into balance;
- o to offer reliable customer services;
- o to offer competitive prices;
- o to capture uncommitted market consistent with financial interests;
- o to minimize the cost of operating existing enrichment plants;
- o to retain the U.S. leadership in advanced technology and deploy as appropriate to meet business objectives; and
- o to adopt a more businesslike institutional structure.

Important progress has been made toward achieving these goals. A summary of some of the more significant accomplishments during the past 2 years follows.

BRING SUPPLY AND DEMAND INTO BALANCE

The US contracts, introduced in January 1984, were a major step which have enabled the enrichment enterprise to compete more

effectively in the international marketplace. About 90 percent of DOE customers converted to these contracts. They have brought stability to our projected sales base and corresponding revenues. They have permitted DOE customers to reduce enriched and natural uranium inventories, and produced a more orderly market serving the nuclear fuel cycle.

Subsequently, representatives of the uranium mining industry brought suit against DOE based on the procedures which were used to introduce the terms of the new contract form. Litigation concerning the US enrichment contract is proceeding in both the U.S. District Court for the District of Colorado and in the U.S. Court of Appeals for the Tenth Circuit. DOE has noticed its appeal of the judgment of the district court in which the court ruled that the US contract was null and void.

OFFER RELIABLE CUSTOMER SERVICES

Reliability of supply is a term we hope will become synonymous with U.S.-supplied enrichment goods and services. We strive continually to offer the world's most reliable enrichment services and to respond quickly to changes in the marketplace. We believe this is a significant factor in utility decisions, both here and abroad, to contract with DOE for their enrichment services.

OFFER COMPETITIVE PRICES

A crucial element of our competitive strategy is the approach to pricing. The market is extremely price sensitive and DOE prices must be competitive. The key to the survival of the U.S. uranium enrichment business is to get near-term prices down into the competitive range by aggressively reducing costs.

The price for US contract holders in 1985 was $135 per separative work unit (SWU). In announcing the June 5, 1985, enrichment program decisions, Secretary Herrington pointed out that maintaining the DOE price at uncompetitive levels was, in effect, a going out of business strategy. On October 1, 1985, a price reduction to $125 per SWU became effective. This price is still significantly higher than those currently offered by competitors. Accordingly, DOE has announced its plans to continue its price reduction policy by offering a FY 1987 base price of $119 per SWU effective October 1, 1986.

This declining pricing pattern for the U.S. adds credibility to plans for even lower prices in the future. The results of not following a competitive pricing strategy would have serious impact on the enterprise. It is estimated that DOE would lose about $7 billion in revenues between now and the year 2000 if it were to keep prices at the current $125 per SWU level. Thus, our pricing policy is crucial to the competitive strategy.

CAPTURE UNCOMMITTED MARKET

During the past year, we have taken strong actions to revitalize this country's uranium enrichment enterprise. Most notably, through several creative marketing initiatives, we were able to increase our share of the free world enrichment market from 46 percent in 1985 to 53 percent in 1990.

In 1985, there remained 6 million SWU's of uncommitted sales opportunities with DOE enrichment customers available from FY 1987 through FY 1990. During this period, DOE has excess production capacity that could produce SWU's at low marginal costs. To allow its customers to benefit from this capability, in April 1985, DOE offered an incentive price of $90 per SWU to customers with uncommitted sales in FY 1987 through FY 1990. This incentive pricing offer proved very successful-- nearly 87 percent of DOE customers with uncommitted requirements accepted the incentive price proposal. As a result, DOE sales for FY 1987 through FY 1990 time period increased by 14 percent, or over 5 million SWU's.

In 1986, we hope to solidify and increase our market share for the period 1991-1995. By April 1, 1986, DOE customers must decide how much of their fuel supply they will take from DOE in FY 1991. Over 25 percent of DOE's US contract enrichment demand is uncommitted from FY 1991 through FY 1995. Total sales opportunities are about 20 million SWU's with a sales value of about $2 billion.

In light of our previously successful pricing effort, we have made a new incentive pricing offer to our customers. In return for customer commitments to purchase 100 percent of their enrichment requirements from DOE in the 5-year period from FY 1991 to FY 1995, DOE has proposed a price of about $85 per SWU for the remaining 30 percent fraction of their enrichment requirements. Under US contracts, 70 percent of the customers' enrichment requirements would be priced at the DOE base price.

I am pleased to announce that we have had a very favorable response to our incentive price offer. Those customers who took advantage of this highly attractive offer represent about 75 percent of DOE's uncommitted sales opportunities in the FY 1991-1995 time period.

We plan to continue aggressive market initiatives in the future to increase DOE's market and revenues, discourage competitor investment in new capacity, improve the U.S. trade balance, prevent competitor penetration of DOE's market share, and effectively utilize excess DOE production capacity. In addition, a larger sales volume to DOE will result in lower unit production costs which could be passed along to all customers in the form of lower prices.

MINIMIZE COSTS OF EXISTING PLANT OPERATIONS

Because minimizing the cost of existing plant operations is key to near term DOE price competitiveness, Secretary Herrington decided in June 1985 to place the Oak Ridge (Tennessee) Gaseous

Diffusion Plant in standby status at the earliest possible date. This major, near-term cost reduction decision followed extensive analysis that showed that about $250 million could be saved between FY 1986 and FY 1991 by taking that action. The Oak Ridge Gaseous Diffusion Plant has been in standby status since August 1985, and will remain in that condition with the DOE Office of Defense Programs providing the standby funding because of projected defense demands for enriched uranium in the outyears. If the standby funding is not provided, the plant will be shut down permanently. If the plant is permanently shut down, it will not be operable because critical components will no longer be maintained.

The costs of operating the Portsmouth and Paducah Gaseous Diffusion Plants (GDP's) were also reduced in FY 1985. New and innovative ways of operation, coupled with the use of lower cost unfirm power which is about 30 percent cheaper than firm power, improved the economics of operating the GDP's. Significant savings have been demonstrated through the use of low-cost evening, weekend, and offpeak seasonal power. It is planned to continue to take advantage of this lower cost, unfirm power to the maximum extent possible in the future.

Another strategically necessary but very difficult cost reduction decision was the termination of the GCEP project. After extensive analyses, the Department concluded that any GCEP completion scenario that required the outlay of significant amounts of additional capital was unjustifiable from an

investment point of view. Simply put, the best GCEP scenarios resulted in production costs that were about equal to the production costs of the GDP's that are operating today, and all GCEP scenarios involved greater technical and economic risks than continued GDP operation.

Closeout of GCEP-related activities is proceeding well and DOE is working diligently to identify alternative uses for the GCEP equipment and facilities as well as other centrifuge facilities throughout the country.

RETAIN U.S. LEADERSHIP IN ADVANCED TECHNOLOGY

The U.S. currently enjoys a commanding lead in developing the world's most advanced enrichment technology, the AVLIS process. We plan to maintain that lead to assure that, even when other countries decide to deploy AVLIS, the U.S. will have a more advanced, lower cost process on line.

The figures of merit that favored the selection of AVLIS over the Advanced Gas Centrifuge for further development clearly showed its greater potential for low cost and reliable production for the future. The AVLIS technology is less capital intensive, requires significantly less investment prior to a decision to deploy, has a lower estimated SWU cost, has greater potential for cost reductions through technology improvements, and is more adaptable to deployment in increments that can match the evolving needs of the enrichment marketplace.

In FY 1985, the one-half scale MARS separator was successfully integrated with the first phase of the Laser Demonstration Facility for enrichment tests. Test results will establish an experience base in the operation of large scale integrated hardware as well as calibrate the consistency between model prediction and measured enrichment performance. The near full scale Materials Handling Demonstration Module was operated continuously for over 100 hours, thereby establishing the initial key segment of materials handling technology for design and operation of a full-scale separator pod.

In FY 1986, these facilities will be used to demonstrate enrichment for extended periods of time and to demonstrate the materials handling capability of this subsystem. Attention will focus on resolution of issues identified by the Process Evaluation Board as being technically critical or having high economic leverage.

Ultimately, the successful deployment of AVLIS will depend in large measure on the existence of qualified industrial capability to carry the AVLIS technology out of the laboratory and into commercial operation. Accordingly, we will be instituting an industrial access program for AVLIS this year in an attempt to develop a knowledgeable industrial base for deployment.

RECOVERY OF PRIOR GOVERNMENT COSTS

The Government's outstanding investment will be recovered in a manner that will assure that commercial and military customers

will continue to obtain competitively priced enrichment services. The Administration is committed to the recovery of appropriate Government costs over a reasonable period of time as required by the Atomic Energy Act. DOE will return to the U.S. Treasury, over a reasonable period of time, previously unrecouped and unrecovered costs associated with the provision of enrichment services to civilian customers. The outstanding Government investment will be reduced from $7.5 billion to approximately $3.5 billion by an amount equivalent to 60 percent of the GDP's that are no longer an earning asset and the entire GCEP, which never was and never will be an earning asset. These assets are not being used to provide enrichment services for the benefit of commercial customers. In addition, the outstanding investment will also be reduced by amounts equal to imputed interest charges after these assets were deemed to be "nonearning." These amounts are shown on the table below.

	($ in Millions)
Total Government Investment	$ 7,573
Less: 60% of GDP investment	1,200
GDP imputed interest	193
GCEP investment	2,589
GCEP imputed interest	110
Total Unrecovered Investment	$ 3,481

Imputed interest on the outstanding investment made prior to October 1, 1986, will be computed at an interest rate of 6.319 percent--the average of Treasury rates applicable in the years in which net increases in Government investment occurred, weighted by the dollar amount of these annual increases.

Payments to Treasury will be set for each fiscal year and the subsequent year through the annual budget process. The Department plans payments to the Treasury of $110 million in FY 1986 and $235 million in FY 1987.

MODIFICATION OF THE URANIUM ENRICHMENT SERVICES CRITERIA

One key action recently initiated by DOE is the proposed modification of the Uranium Enrichment Services Criteria. A Notice of Proposed Rulemaking was published in the Federal Register on January 29, 1986. The proposed Criteria modification addresses: (1) items that were questioned in the miners' lawsuit; (2) other aspects of the enterprise, including flexibility for future competitive actions; and (3) reiteration of the Administration's position opposing restrictions on the enrichment of foreign natural uranium.

We hope to complete the rulemaking process by the end of summer. All interested parties will have an opportunity to comment on the proposed Uranium Enrichment Services Criteria, both in writing and at a public hearing.

Subsequent to the review and consideration of public comments, DOE will submit the revised Uranium Enrichment Services Criteria to Congress at least 45 days prior to their actual effective date pursuant to Section 161(v) of the Atomic Energy Act.

This completes my statement. I would be pleased to respond to any questions you may have at this time.

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